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VOLUME 54 **APRIL 1951** NUMBER 640

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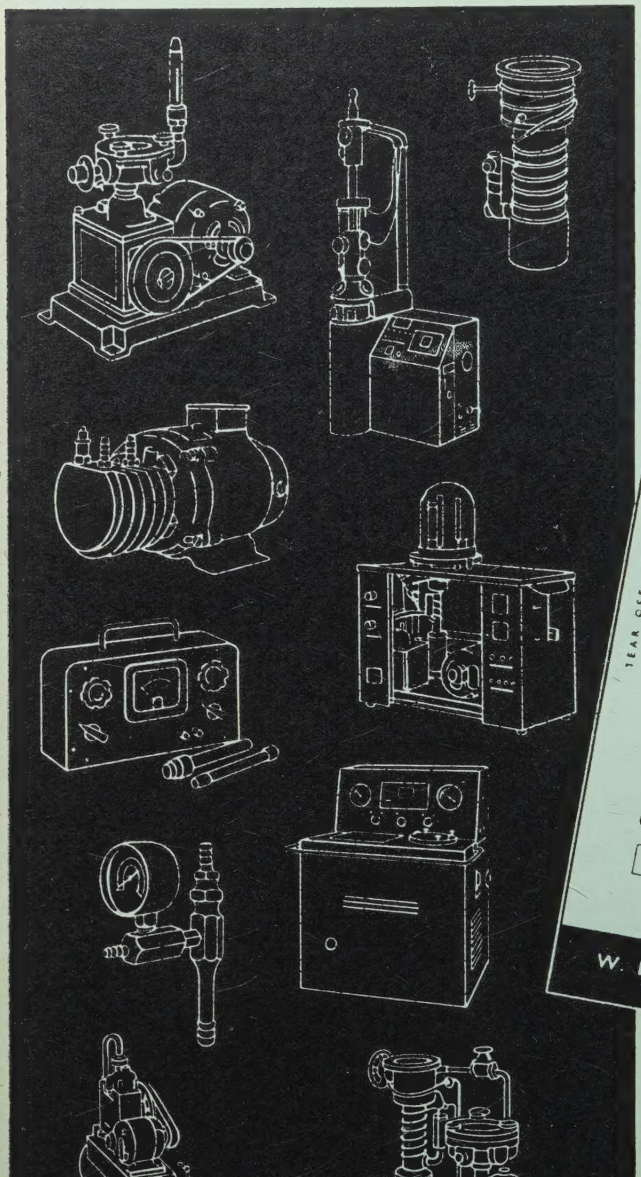

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Principal Contents

APRIL 1951

		PAGE
51	MATHEMATICS	265
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	266
53	PHYSICS	273
530.1	Fundamentals	273
531	General mechanics. Mechanics of solids	278
531.7	Mechanical measurements	278
532	Mechanics of fluids	279
532.6	Capillarity	280
532.7	Molecular theory of liquids	281
533	Mechanics of gases	282
533.7	Molecular theory of gases	285
534	Vibrations. Acoustics	285
535	Optics. Radiation. Spectra	288
536	Heat	300
536.7/.8	Thermodynamics	305
537	Electricity	305
537.1	Theory. Electrons	305
537.2	Electrostatics. Dielectrics	306
537.3	Electric conduction. Currents	309
537.52	Electric discharges	212
537.531	X-rays	314
537.533/.534	Cathode rays. Positive rays	314
537.54	Discharge tubes. Counters	319
537.56/.58	Ionization. Thermionics	320
537.591	Cosmic rays	320
538	Magnetism	325
538.3/.5	Electromagnetism. Electrodynamics	328
538.56	Electromagnetic waves and oscillators	328
538.6	Magnetic effects	332
539.1	Molecular and atomic structure	332
539.11	Theory of solid state	332
539.13	Molecular structure	333
539.15	Atomic structure. Nucleus. Isotopes	335
539.16	Radioactivity. α-, β- and γ-rays	339
539.17	Nuclear reactions	345
539.18	Atom and molecule beams. Mesons. Neutrons	349
539.2	Structure of solids	351
539.3/.8	Elasticity. Strength. Rheology	354
541	PHYSICAL CHEMISTRY	357
541.11/.12	Phase equilibrium. Chemical reactions	357
541.13	Electrochemistry	362
541.14	Photochemistry. Radiation chemistry	363
541.18	Dispersions. Colloids. Adsorption	364
541.4/.6	Chemical structure	365
542.1/.7	Laboratory apparatus	—
543/545	Chemical analysis	367
548	CRYSTALLOGRAPHY	368
548.7	Molecular and X-ray crystallography	369
55	GEOPHYSICS	371
551.5	Atmosphere. Meteorology	373
57/59	BIOLOGY	375
61	Medical science. Human physiology	375
66/67	TECHNICAL MATERIALS	—
77	PHOTOGRAPHY	375

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Amer. Math. Monthly*	*The American Mathematical Monthly.* [Abstracted by *Mathematical Reviews.*]
**Anglo-American Council on Productivity*	*Anglo-American Council on Productivity.* 21 Tothill Street, London, S.W.1; 2 Park Avenue, New York, N.Y.
Arch. Math. Naturv.	*Archiv for Mathematik og Naturvidenskab.* The Faculty of Mathematics and Science, The University of Oslo, Blindern, per Oslo. [Correction to entry in 1950 List.]
**Arch. Met. Geophys. Bioklimatol. Ser. A*	*Archiv für Meteorologie, Geophysik und Bioklimatogie, Serie A.* [Abstracted by *Meteorological Abstracts.*]
Astron. Nachr.	*Astronomische Nachrichten.* [Alteration to entry in 1950 List.]
Astrophys. Norveg.	*Astrophysica Norvegica.* The Faculty of Mathematics and Science, University of Oslo, Blindern, per Oslo.
Avh. Norske VidensAkad. Oslo. I. Mat.-Nat. Kl.	*Avhandlingar utgitt av Det Norske Videnskaps-Akademi i Oslo.* I. *Matematisk —Naturvidenskaplige Klasse.* The Faculty of Mathematics and Science, University of Oslo, Blindern, per Oslo.
Canad. J. Chem.	*Canadian Journal of Chemistry.* [Formerly *Canadian Journal of Research, Section B.*]
Canad. J. Math.	*Canadian Journal of Mathematics.* [*Journal Canadien de Mathématiques.*] University of Toronto, Toronto.
Canad. J. Phys.	*Canadian Journal of Physics.* [Formerly *Canadian Journal of Research, Section A.*]
Canad. J. Techn.	*Canadian Journal of Technology.* [Formerly *Canadian Journal of Research, Section F.*]
Curr. Sci.	*Current Science.* The Current Science Association, Malleswaran P.O., Bangalore 3. [Amplification of address in 1950 List.]
**Dtsch. Wetterdienst U.S. Zone, Ber.*	*Deutscher Wetterdienst in der U.S. Zone, Berichte.* [Abstracted by *Meteorological Abstracts.*]
**Geophysica, Helsinski*	*Geophysica, Helsinski.* [Abstracted by *Meteorological Abstracts.*]
**Hemel en Dampk.*	*Hemel en Dampkring.* [Abstracted by *Meteorological Abstracts.*]
J. Canad. Math.	*Journal Canadien de Mathématiques.* [See under *Canadian Journal of Mathematics.*]
Meded. K. Vlaamse Acad. Wetensch. Belg.	*Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België.* Palais der Acadamiën, Brussels. [Correction to, and amplification of, entry in 1950 List.]
Mullard Tech. Rep.	*Mullard Technical Report.* Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2.
Pakistan J. Sci.	*Pakistan Journal of Science.* Pakistan Association for the Advancement of Science, University Institute of Chemistry, The Mall, Lahore. [Amplification of entry in 1950 Supplement.]
Pakistan J. Sci. Res.	*Pakistan Journal of Scientific Research.* [Published with *Pakistan Journal of Science.*] Pakistan Association for the Advancement of Science, University Institute of Chemistry, The Mall, Lahore.
Skr. Norske VidenskAkad. Oslo. I. Mat.-Nat. Kl.	*Skrifter utgitt av Det Norske Videnskaps-Akademi i Oslo.* I. *Matematisk —Naturvidenskaplige Klasse.* The Faculty of Mathematics and Science, The University of Oslo, Blindern, per Oslo.
Techn. Rep. Tôhoku Univ.	*Technology Reports of the Tôhoku University.* Tôhoku University, Sendai.
Telecomunicazione	Formerly listed under *Telecomun.*
**U.S. Air Force Cambridge Res. Lab., Geophys. Res. Pap.*	*U.S. Air Force Cambridge Research Laboratories, Geophysical Research Papers.* [Abstracted by *Meteorological Abstracts.*]
Verh. K. Vlaamse Acad. Wetensch. Belg.	*Verhandelingen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België.* Paleis der Academiën, Brussels.
**Wetter u. Leben*	*Wetter und Leben.* [Abstracted by *Meteorological Abstracts.*]

MATHEMATICS 51

512.31

2291. Associated Legendre polynomial approximations. R. LANDAUER. *J. Appl. Phys.*, **22**, 87–9 (*Jan.*, 1951).

Approximations for the associated Legendre polynomials are derived by a phase integral method. The method is an extension of the WBK method, applicable to separable multidimensional wave propagation problems. A.

512.831

2292. An iteration method for the solution of the eigenvalue problem of linear differential and integral operators. C. LANCZOS. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 255–82 (*Oct.*, 1950).

The present investigation designs a systematic method for finding the latent roots and the principal axes of a matrix, without reducing the order of the matrix. It is characterized by a wide field of applicability and great accuracy, since the accumulation of rounding errors is avoided, through the process of "minimized iterations." Moreover, the method leads to a well convergent successive approximation procedure by which the solution of integral equations of the Fredholm type and the solution of the eigenvalue problem of linear differential and integral operators may be accomplished. A.

517.941.91

2293. Asymptotic solutions of ordinary linear differential equations of the second order. I. IMAI. Letter in *Phys. Rev.*, **80**, 1112 (*Dec.* 15, 1950).

517.942.4

2294. Discriminant curve and domain of aperiodic continuity. B. V. BULGAKOV. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1143–4 (1950) *In Russian.*

Mathematical. Every point in the $\mu\nu$ plane corresponds to definite coeffs. in the equation $\Delta z = 0 \equiv P(z)\mu + Q(z)\nu + R(z)$. The region of negative roots gives that of aperiodic continuity; if $\Delta(z) = 0$ is the characteristic equation of a linear oscillating system, all partial vibrations vanish exponentially there. A rule is given for the number of pairs of complex roots in a given domain. J. JACOBS

518.5

2295. An index of nomograms. D. P. ADAMS. *Cambridge, Mass., The Technology Press of M.I.T.; New York, John Wiley & Sons; London, Chapman & Hall* (1950) ix + 174 *pp.*

A list is given of about 1 700 references to alignment charts appearing since 1923 in about 100 technical journals, chiefly American.

MATHEMATICAL REVIEWS

518.5

2296. Programmed digital calculators (electronic calculating machines). A general survey. II. H. RUTISHAUSER, A. SPEISER AND E. STIEFEL. *Z. angew. Math. Phys.*, **1** (*No.* 6) 339–62 (1950) *In German.*

In continuation of a previous paper [Abstr. 783 (1951)] the arithmetical principles underlying the design and operation of electronic calculating machines are described. It is convenient for ease of design to work in the binary scale: but, as most of the information fed to, and required from, such a machine is in the denary scale, some machines encode each denary digit as a separate group of 4 binary digits; various encoding systems of this type are outlined. Some machines accept a number simply as an ordered sequence of digits; in others the position of the decimal point can also be specified. The differences in carrying out the 4 fundamental arithmetical processes on the two types of machine are discussed and illustrated by numerical examples. Other topics include the attainment of higher accuracy by artificially introducing a numerical scale of a higher order, and the process of rounding-off errors. A. SCHOFIELD

518.5

2297. An analogue multiplier. B. O. MARSHALL, JR. Letter in *Nature, Lond.*, **167**, 29–30 (*Jan.* 6, 1951).

518.5 : 517.63

2298. On the multiplication of real numbers. W. EBERL. *Z. angew. Math. Phys.*, **1** (*No.* 6) 411–13 (1950) *In German.*

A method is outlined which, though in common use with calculating machines in the U.S.A., has not previously been published. A single transformation to a power series leads to an approximate answer, differing from the exact product by an amount shown, by a simple series summation, to be essentially small. With the aid of a nomogram the method is well adapted for setting up as a machine problem.

A. J. KENNEDY

518.5 : 621.317.39

2299. New techniques on the Anacom—electric analog computer. E. L. HARDER AND J. T. CARLETON. *Trans Amer. Inst. Elect. Engrs*, **69** (*Pt I*) 547–56 (1950).

The Anacom is a general purpose computer, capable of solving problems by various techniques, but is particularly adapted for direct analogue methods. The advantages of the feedback ("sigma") amplifier—which combines adding, integrating and delay in a single unit—are described, certain design problems having been simplified. Examples are given of the application of the computer to certain problems (e.g. speed regulator systems). Devices for the reproduction of arbitrary functions are described, including a non-linear resistor composed of rectifying elements, d.c. voltage sources and linear resistors, providing an approximation to monotonic functions by a series of straight-line sections. The photoformer (c.r.o. with template mask and photoelectric feedback), not so limited to monotonic functions, is also discussed. Application to fluid flow, magnetic amplifier, and other non-linear systems is considered. The analogue study of the action of corona in limiting transient overvoltages on h.v. lines is briefly outlined. A. J. KENNEDY (R)

518.5 : 621.317.727

2300. Electrical representation of functions. F. V. MAĬOROV. *Elektrichestvo, No.* 11, 51–7 (*Nov.*, 1950) *In Russian.*

It is claimed and proved that Korn's description of a universal functional generator with potentiometers [Abstr. 4597 (1950)] was years behind the author's publication of his invention of potentiometer arrangements for representing functions of one, two and three variables by voltages [*Izv. Akad. Nauk, Otdel., Tekh. Nauk*, **11**, 1576 (1947)]. The electric "profiling" of the potentiometers is obtained by impressing the required voltage distribution on the potentiometers by means of shunt resistances across sections of the potentiometer. A wide variety of functions can be so represented by using variable resistance boxes as shunting resistances. The functions represented may be analytical or tabular, monotonic or not, changing sign and having discontinuities. The paper describes principle and general lay-out of the instrument, and the actual design of the potentiometer elements. The accuracy is of the order 0·01–0·02%.

B. F. KRAUS (R)

518.5 : 621.318.572

2301. Universal high-speed digital computers: a small-scale experimental machine. F. C. WILLIAMS, T. KILBURN AND G. C. TOOTILL. *Proc. Instn Elect. Engrs, Pt II*, **98**, 13–28 (*Feb.*, 1951) [*Reprint No.* 1052].

Numbers are represented by the serial binary digit system, the 32 digits of a number being stored as charge patterns on a c.r.o. screen [see Abstr. 2862 (1949)]. Storage capacity and complexity of computation are limited, but the principles involved have provided a basis for more advanced design. Its operation and construction are described in detail with discussion of circuits and waveforms.

A. J. KENNEDY (R)

518.5 : 621.3.042 : 621.318.572

2302. Digital information storage in three dimensions using magnetic cores. J. W. FORRESTER. *J. Appl. Phys.*, **22**, 44–8 (*Jan.*, 1951).

Present digital storage devices use two space co-ordinates or time and one space co-ordinate for selection switching, resulting in bulky construction or long access time. Three-dimensional arrays with efficient high-speed selection appear possible after continued development of rectangular-hysteresis magnetic materials. An operating mode is suggested which depends on ability of the magnetic material to discriminate between two values of magnetizing force which differ by a 2 : 1 ratio. Only one magnetic core per binary digit is required. Tests show that most existing metallic magnetic materials switch in 20 to 10 000 μsec and are too slow. Non-metallic magnetic materials can now approach the required magnetic behaviour; they switch in < 1 μsec. A.

519.281.2

2303. Estimation of the errors of the least-squares polynomial coefficients. P. G. GUEST. *Aust. J. Sci. Res., A*, **3**, 364–75 (*Sept.*, 1950).

The estimation of the errors in the values obtained for the power-series and differential coefficients of a least-squares curve fitted to a number of equally-spaced observations is discussed. Curves and tables of the various weight functions are obtained. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.042 : 539.17

2304. On the origin of the lighter elements. W. BAND. *Phys. Rev.*, **80**, 813–18 (*Dec.* 1, 1950).

Maria Mayer and Teller have proposed accounting for the relative abundances of the heavier elements as products of the fission of a cold polyneutron fluid. The present paper proposes to account for the lighter elements as having been formed at an earlier stage in evolution when temperatures were high enough to permit nuclear reactions, and the primordial neutron-rich nuclear fluid first separates into two phases: the condensed super-clusters or stars which eventually cool to become the Mayer–Teller polyneutrons, and an atmosphere or vapour of small clusters that become the lighter elements. The quantum statistics of a dissociative clustering nucleon gas is worked out and yields equilibrium abundances of the small clusters or light nuclei in the vapour that agree qualitatively with the observed abundances if the temperature T of the equilibrium is assumed to be such that $kT = 5$ MeV. A.

521.4

2305. Laws of planetary distances and planetary revolution. L. E. GUREVICH AND A. I. LEBEDINSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 6) 1061–4 (1950) *In Russian.*

Theoretical. Equations are deduced for planetary distances and for the relation between their masses and rotation. The effect of the eccentricities of the planetary orbits are discussed and empirical corrections are applied to the equations deduced, which lead to values for the planetary orbits in fair agreement with accepted experimental values, e.g. the empirical equation for the nth planet is $10\,g \cdot R_n = 10\,g \cdot R_6 + 0{\cdot}301\,(n-6) + \alpha(n-6)^3 + \ldots R_6$ being the orbital radius of Jupiter. W. HUGHES

522.2 : 523.75

2306. A chromospheric telescope. S. B. IOFFE, I. A. PROKOFEVA AND M. S. EIGENSON. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 629–30 (1950) *In Russian.*

It is claimed that the invention of a filter for interference polarization enables the sun to be observed in sections of the spectrum practically limited to Hα. For this purpose the model of a new chromospheric telescope was built in 1950 at the Pulkov Observatory.

J. CLEUGH

522.21 : 535.211

2307. Correction of thermal deformations of telescope mirrors. A. COUDER. *C.R. Acad. Sci., Paris*, **231**, 1290–1 (*Dec.* 9, 1950) *In French.*

Describes experiments to correct the deformations of the main mirror of the 81 cm reflector at Haute Provence, due to the difference of rate of cooling of

the mass of glass as compared with the steel tube of the instrument. The mirror is 7·6 cm thick, having, at the Cassegrain focus, a focal length of 12 m, and a temperature fall of one degree per hour produces an over-correction up to 3 times the Rayleigh limit, corresponding here to a longitudinal marginal aberration of 2 mm. The experiments were made by applying a network of fine wire in contact with the back of the mirror in the form of a zone between 58 and 71 cm dia. and observing the effect when the wire was electrically heated. The results are given and it is proposed to install this form of corrector to other instruments. It is suggested that the method could be used on solar coelostat mirrors. E. G. MARTIN

522.612 : 535.33.072

2308. Spectrograph for the Radcliffe Observatory, Pretoria. J. JACKSON. *Nature, Lond.*, **167**, 169–70 (*Feb.* 3, 1951).

Gives details of the recently completed spectrograph for use at the Cassegrain focus of the 74 in reflector, to determine radial velocities of stars in the southern hemisphere. Two 64° prisms produce the spectra and 4 cameras varying from *f*2 to *f*8 can be used. Great care has been taken to secure rigidity of the optical parts to avoid distortions arising during the long exposures. This spectrograph completes the telescope designed nearly 15 years ago.

E. G. MARTIN

523.1 : 538.3

2309. Cosmical electrodynamics. H. ALFVÉN. *Clarendon Press, Oxford* (1950) 237 *pp.*

Deals with the influence of electric forces in astrophysical and geophysical problems. Reviews existing knowledge on the motion of charged particles in magnetic fields, electric discharges in gases, and magneto-hydrodynamic waves. Discusses applications to solar physics, magnetic storms and aurorae, and cosmic radiations.

523.112

2310. On the interpretation of Hubble's expansion law for the universe. E. BAGGE. *Phys. Bl., No.* 12, 533–8 (1950) *In German.*

See Abstr. 8436 (1950). In discussing Milne's Newtonian parabolic universe it is suggested that t_0 must be non-zero in the expansion law $V = \frac{2}{3}R/(t - t_0)$. R. A. NEWING

523.112 : 530.12

2311. On the general motion of matter at the cosmological scale. A. GIÃO. Letter in *Phys. Rev.*, **80**, 755–6 (*Nov.* 15, 1950).

See Abstr. 20 (1951). Rotational motion associated with a slightly deformed de Sitter universe is further discussed. It is emphasized that the motions considered arise from non-Newtonian forces, and it is suggested Newtonian gravitation is of decisive importance only for smaller scale motions.

R. A. NEWING

523.12

2312. Erratum: Theory of the origin and relative abundance distribution of the elements. R. A. ALPHER AND R. C. HERMAN. *Rev. Mod. Phys.*, **22**, 406 (*Oct.*, 1950). See Abstr. 6951 (1950).

523.154

2313. Planetocentric effect of radial retardation. V. V. RADZIEVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 197–200 (1950) *In Russian.*

Begins with a formula for the time taken by a spherical particle of a given radius and density from the beginning of its orbital circulation, at a given distance from the sun, to its final fall into the latter as a result of the heliocentric effect of radial retardation. A formula is then given for the pressure of light upon such a particle at the centre of its orbit, where its diameter exceeds the length of the light-wave. Expressions are subsequently found and combined for (*a*) the dependence of light-pressure power on radial velocity, and (*b*) the tangential component, whence the density coefficient is obtained. On this basis the time taken for the radius of the orbit to diminish by a given distance is calculated, and results obtained for Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. In conclusion some consequences of these results, affecting cosmogony, are indicated. J. CLEUGH

523.161

2314. The expansion of an interstellar gas-cloud into a vacuum. G. C. MCVITTIE. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 3) 224–37 (1950).

Riemann's work is summarized for the case of the adiabatic one-dimensional motion of an interstellar gas-cloud expanding into a vacuum. Boundary conditions are found for: (A) a homogeneous (isothermal) gas-cloud; (B) a non-homogeneous cloud having a temperature-gradient perpendicular to the face advancing into the vacuum. Due to the asymmetry of the boundary conditions, it is not possible to prove that one of the Riemann variables, *s*, is constant in case (A). A general solution of the problem is given for case (A) under assumption that *s* is constant and relation to Burgers' particular solution. Atoms of the gas at the advancing face are shown to be given an initial impulsive velocity in case (A). A general solution is given for case (B), in which neither Riemann variable is constant. The advancing face is shown to be permanently the seat of "shock" conditions. The method of fitting the solution to any law of temperature-variation in the cloud is given *a priori*. A particular example is worked out in detail which suggests that Burgers' high speed of advance of the face into the vacuum is attainable only after an infinite time. A.

523.161

2315. The expansion of a gas cloud into a vacuum. E. T. COPSON. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 3) 238–46 (1950).

The paper solves by Riemann's method the one-dimensional problem of the expansion of a gas cloud into a vacuum. The cloud is initially at rest, and is homogeneous except for a boundary layer of arbitrary thickness. Motion starts in the non-homogeneous layer, and spreads into the cloud. The solution uses Riemann's variables $r = \frac{1}{2}(3c + u)$, $s = \frac{1}{2}(3c - u)$, where c is the local velocity of sound, u the gas velocity. In the first stage of the motion there are 3 moving boundaries. In the second stage the quantity r is constant everywhere. The cloud still

advances into the vacuum, and the motion spreads as before into the cloud. This state is similar to one discovered by Burgers. The difficulty regarding the discontinuity in the initial state of Burgers' solution is shown to be due to the fact that his solution is a limiting case of the present solution when the thickness of the initial layer of non-homogeneity is made to vanish. A.

523.161

2316. Intergalactic matter. F. ZWICKY. *Experientia*, 6 (*No.* 12) 441–5 (1950).

Observational evidence for the existence of intergalactic stars and star-systems, and other intergalactic matter, is discussed, and it is suggested that when allowance is made for this material and for the faint galaxies recently revealed the mean density in the universe may be as great as 10^{-26} grams/cm.^{3}

M. W. OVENDEN

523.161

2317. Gravitational condensation of a dust cloud. L. E. GUREVICH AND A. I. LEBEDINSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 673–6 (1950) *In Russian.*

Theoretical. Equations are derived expressing the necessary conditions for gravitational condensation. The mechanism of formation of the planets from a cloud of diffuse matter formerly surrounding the sun based on the conclusions drawn from these equations does not correspond to what actually happens since the cloud is not homogeneous, but at any moment consists of masses of different weights. The mechanism of planet formation is more accurately described by O. Yu. Schmidt's hypothesis [*Dokl. Akad. Nauk, SSSR*, **45** (*No.* 6) (1944)]. W. HUGHES

523.161 : 523.2

2318. The properties of clouds from which the planets of the solar system are formed. L. E. GUREVICH AND A. I. LEBEDINSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 5) 905–7 (1950) *In Russian.*

Theoretical. Gravitational condensation of the diffuse matter formerly surrounding the sun is only possible for a dust cloud and not for a gas cloud, so that the cloud surrounding the sun immediately preceding the formation of the planets must have been a dust cloud. This is generally accepted; the question at issue is the origin of the primary cloud. It is proposed that the cloud was initially gaseous and had a chemical composition approaching that of the stars and mass and moment of momemtum approx. the same as the mass and moment of the present system. As a result of condensation of metals and high-melting materials from the gas into fine dust, the dust cloud formed should be completely opaque. This forms a disk-like cloud while the gaseous part remains practically spherical. Since the dust cloud is opaque and the gaseous part transparent to the sun's radiation, the cloud particles will be cooled to such an extent that the gaseous part will condense on them. A small part of the disk near to the sun will be subject to heating and this part will consist of non-volatile matter which condenses to give the inner planets. Most of the gas cloud will condense on the colder part of the disk to form the outer planets which, since they will contain the more volatile matter, H compounds and mol. H_2, etc., will have a low density. W. HUGHES

523.161 : 523.877

2319. On the Doppler broadening of absorption lines by turbulence and by multiple interstellar clouds. S.-S. HUANG. *Astrophys. J.*, **112**, 339–417 (*Nov.*, 1950).

The influence of turbulence on an absorption line is studied in a way similar to that customarily used in treating the influence of thermal motions on the line. A mean line-absorption coefficient for the turbulent absorbing gas is first calculated on the assumption of various distribution functions for eddy velocities. This can be separated into two parts: one referring to the core of a line and the other to the wings. It is shown that the effect of turbulence in the wings is negligible; the damping part of the curve of growth is therefore unchanged by its presence. Following a general treatment of the effects of turbulence, line profiles and curves of growth have been computed both for the case of a δ-function distribution of eddy velocities (which is equivalent to a step-function distribution of velocities in the line of sight) and for the case of a Gaussian distribution of eddy velocities. The result of the numerical computation shows that a weak line that has been broadened by turbulence is much shallower than a strong line. It is also found that the flat portion of the curve of growth derived from the δ-function distribution is much lower than that derived from the Gaussian distribution. Thus it is concluded that, unless the real distribution function of eddy velocities is known, the value of the turbulent velocity derived from the curve of growth is uncertain. The broadening of an absorption line by multiple interstellar clouds occurs in the same manner as does the broadening by turbulence; hence the line profiles and the curves of growth of interstellar lines are given directly by the present method. A.

523.162.2

2320. The expansion of the universe and the pressure of light. A. AMERIO. *Atti. Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **9**, 15–16 (*July–Aug.*, 1950) *In Italian.*

Discusses the possibility that nebular red-shifts may arise partly from energy losses due to the collisions of photons with particles of interstellar matter.

R. A. NEWING

523.3

2321. Origin of the moon. K. E. BULLEN. Letter in *Nature, Lond.*, **167**, 29 (*Jan.* 6, 1951).

The resonance theory is re-examined in the light of recent theories of the interior of the earth of Ramsey and Bullen. It is suggested that the moon originated in resonant ejection from a primitive earth-moon body which was unstable due to a hypothetical high-density region caused by pressure and no longer present. M. W. OVENDEN

523.4 : 535.39

2322. Diffuse reflection by planetary atmospheres. H. G. HORAK. *Astrophys. J.*, **112**, 445–63 (*Nov.*, 1950).

An attempt is made to interpret quantitatively the photometric observations which have been made of the planets by using the laws of diffuse reflection recently derived by Chandrasekhar. Consider a planet at a particular phase. By assuming a certain law of reflection, the intensity at any point on the

disk of the planet can be computed. The limb darkening readily follows; however, in order to compute the magnitude of the planet, it is necessary to perform an integration over the visible crescent. This can be accomplished by using an appropriate cubature formula. The problem then consists in finding a law of diffuse reflection which will "predict" the magnitude and limb-darkening observations of a planet. The laws of diffuse reflection are summarized, the geometry of the problem discussed and certain necessary formulae derived; observational data are briefly discussed and results of the computations given, with particular emphasis on Saturn and Venus. A.

523.42 : 550.4

2323. Venus and the Earth's inner core. K. E. BULLEN. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 3) 256–9 (1950).

On the hypothesis that the density changes inside the Earth, down to a depth of 5 000 km, are essentially due to pressure and conform to the writer's compressibility-pressure earth model, it is shown that, if Venus and the Earth are of the same primitive composition, it is more probable than not that Venus contains an inner core. This supports the evidence previously found (on the same hypothesis) from the case of Mars that the Earth's inner core is chemically distinct from the rest of the Earth. A formal relation between the rotation period and the ellipticity of Venus is derived and discussed. A.

523.5

2324. Deceleration and ionizing efficiency of radar meteors. D. W. R. MCKINLEY. *J. Appl. Phys.*, **22**, 202–13 (*Feb.*, 1951).

Improved instrumentation of the radar system has permitted a more accurate analysis of range-time records of meteor echoes and enabled the meteor deceleration to be determined in a few special cases. Three illustrative examples are described in which the measured mean decelerations were $-0{\cdot}48$, $-1{\cdot}1$ and $-1{\cdot}5$ km/sec^{-2}. Velocity data from a continuous wave Doppler system were also available for these meteors and are compared with the radar data. Using existing atmospheric density values and Lovell's scattering formula, it is computed that the ionizing efficiency, or the fraction of the kinetic energy of the meteor converted to ionization, is 10^{-6} for a 60 km/sec meteor and 10^{-8} for a 20 km/sec meteor. If lower values of the air density are adopted, the efficiency figures are increased and at the same time the gap is narrowed between the rates of electron production deduced from loss of mass considerations and the rates calculated from the radar data. More statistical data on radar meteors and further information on the ionizing properties of 1 000 electron-volt atoms are required before definite conclusions can be drawn. A.

523.5 : 551.557

2325. The question of the drift of meteoric tracks. V. P. TSESEVICH. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 677–80 (1950) *In Russian.*

Fedinskiĭ [*Astron. J., USSR*, **21** (*No.* 6) (1944)] worked out a method of observing and calculating the velocity of drift of the luminescent tracks left by certain meteorites. He postulated that the tracks have only a horizontal displacement. It has now been shown as a result of measurements carried out near Odessa in 1948 on meteoric track displacement that Fedinskiĭ's assumption is unsound. Meteoric tracks were observed from two stations 13·63 km apart, and in the case of one of the 11 tracks observed, observations were successfully made simultaneously at the two stations. This track showed a definite vertical displacement. W. HUGHES

523.72

2326. On the interpretation of measured solar wavelengths. L. SPITZER, JR. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 3) 216–19 (1950).

Reasons are given for expecting that collisions with H and He atoms produce a shift of most Fraunhofer lines to the violet rather than to the red. When allowance is made for this effect, and for the many uncertainties in collisional broadening theory, the interferometric measures of solar wavelengths seem consistent with a complete absence of systematic Doppler shifts on the solar surface. A.

523.72

2327. Equivalent path and absorption for electromagnetic radiation in the solar corona. J. C. JAEGER AND K. C. WESTFOLD. *Aust. J. Sci. Res.*, *A*, **3**, 376–86 (*Sept.*, 1950).

Calculations of the trajectories, equivalent path, and absorption of rays, in the frequency range 20–100 Mc/s, in the solar corona have been made, neglecting possible magnetic fields and assuming spherical symmetry. Interpreting the double-humped burst of solar noise as the superposition of a direct and an echo signal, inferences are made as to the height in the corona and location on the solar disk of its source. A.

523.72

2328. Observations of the spectrum of high-intensity solar radiation at metre wavelengths. I. The apparatus and spectral types of solar burst observed. J. P. WILD AND L. L. MCCREADY. *Aust. J. Sci. Res.*, *A*, **3**, 387–98 (*Sept.*, 1950).

An apparatus for recording the dynamic spectrum of high-intensity solar radiation (in particular the sudden bursts) in the frequency range 70–130 Mc/s is described. The spectra are displayed on a cathode-ray tube at intervals of about $\frac{1}{3}$ sec. Solar bursts observed with the apparatus were found to have widely different spectra. However, analysis of a number of bursts indicated the common occurrence of 3 distinct spectral types: (*a*) of narrow bandwidth, exhibited by short-lived bursts that occur during "noise storms" and are presumed to be circularly polarized and associated with sunspots; (*b*) characterized by a slow drift of spectral features towards the lower frequencies, exhibited by sporadic "outbursts" associated with solar flares; (*c*) type in which the frequency of maximum intensity drifts rapidly towards the lower frequencies. The result that outbursts seem to exhibit a distinct type of spectrum is considered to provide a possible means of recognizing these phenomena with certainty. A.

523.72

2329. Observations of the spectrum of high-intensity solar radiation at metre wavelengths. II. Outbursts. J. P. WILD. *Aust. J. Sci. Res., A*, **3**, 399–408 (1950).

Observations in the frequency range 70–130 Mc/s. In accordance with part I (preceding Abstr.), an "outburst" is defined as having a "dynamic" spectrum, characterized by a drift of spectral features towards the lower frequencies at a rate of the order of $\frac{1}{4}$ Mc/s per sec. The observed outbursts are shown to have a close connection with solar flares and their geophysical accompaniments. The spectra are tentatively interpreted in terms of the motion of a physical agency in the solar atmosphere. The possible identification of the agency with "surge" prominences and the corpuscular streams that cause a type of terrestrial magnetic storm is discussed. It is shown that the evidence is quite consistent with the hypothesis that the agency corresponds to the magnetic storm particles. A.

523.72

2330. Comparison of solar radio-wave radiations on two neighbouring frequencies. E.-J. BLUM AND J.-F. DENISSE. *C.R. Acad. Sci., Paris*, **231**, 1214–16 (*Nov.* 27, 1950) *In French.*

Description of some simultaneous observations of solar radio noise on 164 and 156 Mc/s during a quiet period (10 Oct.–10 Nov., 1950). Long calm periods persisting over some days were observed on both frequencies. The detailed fluctuations which occur during storms of weak intensity, show little coherence on the two frequencies. On some occasions there appeared to be appreciable agitation on one frequency (164 Mc/s) with conditions quite quiet on the other (156 Mc/s), as if the source of the perturbation was obscured by a cloud which absorbed the lower-frequency radiation. W. J. G. BEYNON

523.74

2331. The physical meaning of the character figures of solar phenomena. G. RIGHINI AND G. GODOLI. *J. Geophys. Res.*, **55**, 415–22 (*Dec.*, 1950).

Character figures and areas of Ca-flocculi, bright and dark H_α-flocculi are compared for the period 1932–49. The character figures appear to be a function of the areas only. A.

523.746

2332. Prediction of the coming sunspot minimum. W. GLEISSBERG AND A. KIRAL. *Z. Astrophys.*, **28** (*No.* 1) 17–27 (1950) *In German.*

Based on Gleissberg's method of prediction [see Abstr. 4631 (1950)], it is shown that the probability of the next sunspot cycle (Zurich No. 19) commencing within 18 months of the smoothed Wolf number on the descending branch of the present cycle being < 38 is 0·96. The Wolf number at minimum will be > 9 with a probability of 0·95. D. R. BARBER

523.746

2333. On an apparent earth-effect on sunspot activity. M. DIZER. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **15**, 205–11 (*July*, 1950).

It is shown by two independent criteria that the seasonal effect of the earth on observed monthly sunspot numbers claimed by Clough [*Pop. Astron.* **57**, 122 (1949)] is spurious. Attention is directed also to the introduction of an unreal, systematic trend in smoothed monthly sunspot numbers which results directly from the smoothing process. D. R. BARBER

523.746 : 538.566

2334. On Bailey's theory of growing circularly polarized waves in a sunspot. R. Q. TWISS. Letter in *Phys. Rev.*, **80**, 767–8 (*Nov.* 15, 1950). See Abstr. 6212 (1950).

523.75

2335. A study of the eruptive prominence of 1948 September 27. H. W. DODSON AND E. B. WESTON. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 3) 199–205 (1950).

Motions in an eruptive prominence are discussed. The radial velocities of the prominence gases are found to be consistent with the cross-motions shown by the spectroheliograms. This agreement is strong evidence in favour of the hypothesis of moving material. Motions of descending nodules and of an unusual ascending spike are included in the study. A.

523.77 : 523.877

2336. On turbulence in the atmospheres of the sun and the stars. S.-S. HUANG. *Astrophys. J.*, **112**, 418–23 (*Nov.*, 1950).

The effect of turbulence in a stellar atmosphere on absorption lines formed in it is shown to consist of two parts [see Abstr. 2319 (1951)]. Which part a particular eddy contributes to depends on its relative size in comparison with the thickness of the reversing layer. The large eddies broaden the absorption lines without increasing their equivalent widths, while the small ones both broaden the lines and increase their equivalent widths. By using these ideas, an interpretation of the observed data on turbulence in stellar atmospheres is suggested. Thus the most important thing determining the nature of broadening of absorption lines by turbulence is the size of the fastest-moving eddies. As the linear dimension of the fastest-moving eddies can be greater or smaller than, or equal to, the thickness of the reversing layer, it is quite natural not only that the values of turbulent velocity derived from the curve of growth and from the line profiles should disagree in most cases but also that the difference between these values should vary from one star to another. Finally, the turbulent spectrum in the solar atmosphere is considered, and a curve relating the velocity and the size of turbulent elements in the solar atmosphere is plotted as a result of the present analysis of the observed data. This curve modifies the one given recently by Richardson and Schwarzschild. A.

523.774

2337. The profiles of the lines of the Paschen and Brackett series of hydrogen in the solar spectrum. C. DE JAGER AND L. NEVEN. *Proc. K. Ned. Akad. Wet.*, **53** (*No.* 10) 1577–91 (1950).

The profiles of the hydrogen lines in the solar spectrum corresponding with the transitions 3–5, 3–6, 3–7, 3–9, 3–10, 3–11, 3–12, 4–7, 4–10, 4–11, 4–12, 4–13 and 4–14 have been determined with the photoelectric infrared spectrograph. The lines, especially

those of the Brackett series, appear to be extremely broad and shallow; the wings of the latter may be followed even to distances of 50 to 100 A from the line centre. The equivalent widths of the lines of the Brackett series are remarkably great and of the same order as those of the corresponding Balmer lines. The mean error of the mean profile points is of the order of $\pm 6^0/_{00}$; it is greater for the higher series members, which are often seriously blended. A.

523.82

2338. Monochromatic magnitudes observed with a coarse grating. R. V.D. R. WOOLLEY AND K. GOTTLIEB. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 3) 206–15 (1950).

Very low dispersion spectra obtained with a coarse grating in front of a 30 in reflector were used to determine magnitudes at 5 980 Å and 4 480 Å. From internal evidence, and from comparisons (rather few in number) with Hogg and Mason's photoelectric work, the standard error of the mean magnitudes derived is about $\pm 0^m{\cdot}05$. Comparison with Dr. Gascoigne's work indicates that the standard error of the gradients is $\pm 0{\cdot}08$. The method is capable of extension to the 10th magnitude without unduly long exposure time. A.

523.83

2339. Dynamics of the movement of stars through igneous cloud. T. A. AGEKYAN. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 3) 361–4 (1950) *In Russian.*

The cloud studied as an example is assumed to be of cylindrical shape and the reciprocal relative velocity of its motes equal to zero. The trajectory of the movement of each mote is determined by an equation representing its hyperbola. A diagram shows the value, mathematically expressed, of the vector of the complete change in the quantity of movement of the particle taking place as a result of the gravitational pull of the star and also proves that such a vector is directed along the axis of the hyperbola on its inside. A second equation gives the formula for the complete change in the quantity of movement of the star. The light-pressure of the star is then examined, on the preliminary assumption that its strength does not exceed the pull of gravitation. Further equations lead to a diagram illustrating the yielding of the cloud to the star. Equations expressing the acceleration of stars within the cloud are obtained. The conclusion drawn is that the part played by the interaction of such stars with igneous cloud is an essential feature in the study of sidereal dynamics.

J. CLEUGH

523.85

2340. Estimation of the masses of globular- and nebulae-clusters on a dynamical basis. R. KURTH. *Z. Astrophys.*, **28** (*No.* 1) 1–16 (1950) *In German.*

The structure of a new and general model of spherical-symmetrical systems is formulated. Its application to Joy's velocity measurements of single stars in globular clusters [Abstr. 1416 (1950)] shows the total mass of the clusters to be of the order of 1 million sun's masses. An estimation of the mean mass of a single galaxy within the Coma nebulae-cluster leads to 10^{11} sun's masses. A. BEER

523.851

2341. Characteristics of the movements of stars of the spectral classes O and B and extension of the stellar associations. A. F. TORONDZHADZE. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 441–3 (1950) *In Russian.*

523.851

2342. Problem of the evolution of stars in dispersed clusters. A. G. MASEVICH. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 2) 173–6 (1950) *In Russian.*

The luminosity, mass and radius of the sun can be algebraically expressed in terms of its content of H, He and mixed heavy elements; from this equation and that representing the empirical relation between luminosity and mass the evolutionary curve of the sun can be calculated. It is found to resemble closely the contours of the main stellar system. A diagram (Russell's) shows evolutionary curves for different compounds of heavy elements and similar evolutionary curves are given for 14 dispersed clusters [see G. P. Kuiper, *Astrophys. J.*, **86** (*No.* 2) 176 (1937)] together with the absolute bolometric sidereal value M_b—effective temperature. A theory is proposed for the explanation of the dispersion of the general main stellar system and the almost complete absence of such dispersion in the clusters. It is pointed out that the theoretical curve for stars in the early sections of the spectrum departs from the curve observed in practice, while for stars in the later sections the respective curves nearly coincide.

J. CLEUGH

523.852.3 : 530.12

2343. The recession of the extra-galactic nebulae. VI. P. DRUMAUX. *Ann. Soc. Sci. Brux.*, **64, *Sér.* 1**, 169–76 (*Dec.*, 1950) *In French.*

See Abstr. 7713 (1950) for part V. The recession correction for apparent magnitudes calculated by applying the Dirac wave equation to photons is found to be the same as that derived previously from considerations of the relativistic Doppler effect.

R. A. NEWING

523.854

2344. The theory of the fluctuations in brightness of the Milky Way. I. S. CHANDRASEKHAR AND G. MÜNCH. *Astrophys. J.*, **112**, 380–92 (*Nov.*, 1950).

The following statistical problem is considered: Let stars and interstellar clouds occur with a uniform distribution. Let the system extend to a linear distance L in the direction of a line of sight. Let a cloud reduce the intensity of the light of the stars immediately behind it by a factor q. Let the occurrence of clouds with a transparency factor q be governed by a frequency function $\psi(q)$. Given all this, it is required to find the probability distribution, $g(I, L)$, of the observed brightness, I. An integral equation governing the distribution of brightness enables explicit formulae to be obtained for all the moments of g as functions of ξ (av. no. of clouds in line of sight) and the moments of $\psi(q)$. As an illustration of the use of these general formulae for the moments, an example investigated by Markarian has been reconsidered in an attempt to derive the mean and mean-square deviation of the optical thicknesses of the interstellar clouds. A.

523.854

2345. The theory of the fluctuations in brightness of the Milky Way. II. S. CHANDRASEKHAR AND G. MÜNCH. *Astrophys. J.*, **112**, 393–8 (*Nov.*, 1950).

The integral equation governing the fluctuations in brightness of the Milky Way (see preceding Abstr.) is considered for the case in which the system extends to infinity in the direction of the line of sight. The equation is explicitly solved for the two cases in which all the clouds are equally transparent and when the frequency of occurrence of clouds with a transparency factor q is $(n + 1)q^n$. The derived distributions of brightness are illustrated. A.

523.854/.855

2346. Present methods of stellar dynamics as applied to problems of the Milky Way, and extragalactic nebulae. R. COUTREZ. *Scientia*, **45** (*No.* 1) 1–8 (1950) *In French.*

523.854.22

2347. Distribution and origin of the hot giants in our galaxy and other spiral systems. B. A. VORONTSOV-VELYAMINOV. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 5) 911–14 (1950) *In Russian.*

523.854.22

2348. Distribution of hot giants in the outer parts of spiral galaxies. V. A. AMBARTSUMYAN. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 5) 915–16 (1950) *In Russian.*

523.854.3

2349. The mass of the Milky Way system. R. KURTH. *Z. Astrophys.*, **28** (*No.* 1) 60–6 (1950) *In German.*

Using Mayall's recent values for the radial velocities of the globular clusters [Abstr. 1406 (1947)], Zwicky's theorems, as given in *Astrophys. J.*, **86**, 218 (1937), are applied to a system consisting of the Milky Way and these clusters. The resulting mass of the galaxy then becomes 10^{11} sun's masses, with an error-factor between $\frac{1}{2}$ and 2. The agreement with the value derived from the rotational theory of the galaxy is found to be satisfactory. A. BEER

523.872

2350. Electronic temperature of gaseous nebulae: N.G.C. 7027, N.G.C. 6572, N.G.C. 7662, N.G.C. 7009 and Orion. H. ANDRILLAT. *C.R. Acad. Sci., Paris*, **231**, 1432–4 (*Dec.* 18, 1950) *In French.*

Utilizing spectrophotometric intensities, I_1, I_2, I_3, of nebular [O III] lines at 5 007 Å, 4 959 Å, 4 363 Å, respectively, the electron temp. T has been evaluated as a function of the former by substitution in the relation, $(I_1 + I_2)/I_3 = a + be^{c/T}$, the constants a, b and c being already known [Menzel, Aller and Hebb, *Astrophys. J.*, **93**, 230 (1941)]. From spectrograms of 5 nebulae in different degrees of excitation, the following values of T were obtained: N.G.C. 7027–23 000°; N.G.C. 6572–20 000°; N.G.C. 7662–16 000°; N.G.C. 7 009–12 000°; Orion—9 000°. Computed temps. follow excitation levels with the exception, N.G.C. 6 572 for which excitation is weak, and the electronic temp. high. D. R. BARBER

523.875

2351. A correlation between the spectroscopic and dynamical characteristics of the late F- and early G-type stars. N. G. ROMAN. *Astrophys. J.*, **112**, 554–8 (*Nov.*, 1950).

Among the giants and dwarfs in the spectral range F5–G5, some stars have systematically weaker lines than others of the same spectral type and luminosity class. On this basis two groups of stars can be distinguished. An examination of the velocity distributions of the two groups shows definite differences. The velocities of the stars with weaker lines have a larger dispersion than those of the stars with stronger lines; the conventional "high-velocity" stars occur only in the weak-line group. The two types of stars are about equally numerous among the bright northern stars. Stars with velocities less than 70 km/sec are found in both groups. A.

523.877

2352. Turbulence and the curve of growth. M. H. WRUBEL. *Astrophys. J.*, **112**, 424–33 (*Nov.*, 1950).

Although eddies of all sizes affect the absorption-line contour, small eddies have greater effect upon the total absorption and the curve of growth. A weighting function $s(k)$ is derived for various circumstances of line formation. It is shown that all eddies of diameter smaller than $2\frac{1}{2}$ times the scale height of the atmosphere appear in the curve of growth. Therefore, to explain the large differences observed in supergiant spectra between line contours and curves of growth, this theory requires a spectrum of turbulence with considerable energy in very long wavelengths. Such a spectrum may possibly be due to the effect which turbulence at deep layers may have upon the higher regions of the atmosphere in which the lines are formed. A.

525.35

2353. The variations of latitudes and the movement of the terrestrial pole of rotation. G. CECCHINI. *Bull. Géod., No.* 17, 325–61 (*Sept.*, 1950) *In Italian.*

An exhaustive study of the data from the international latitude stations between 1900 and 1949 leads to the conclusion that the mean pole remained practically stationary between 1900 and 1935 and has since shown a slight tendency to westward displacement. The latitude of Mizusawa decreased by 0·120″ between 1900 and 1925, and that of Kitab increased by 0·070″ between 1934 and 1949; the latitudes of the other stations remaining unchanged.

E. M. FOURNIER D'ALBE

525.73 : 551.510.5

Gaseous tail of the earth. *See Abstr.* 3233

526.92 : 621.396.9

2354. The application of radar to geodetic surveying. J. WARNER. *Aust. J. Appl. Sci.*, **1**, 133–46 (*June*, 1950).

In the precise measurement of long lines the results of a large number of radar measurements of 6 distances varying from 160 to 310 miles in length using a modified "Shoran" radar equipment, indicate that an accuracy of about 7 parts in 100 000 can be achieved. Equipment errors constitute the immediate limit to accuracy, but reasonable modifications would yield a figure of 2 parts in 100 000. Radar measurements using the technique described can be completed in a fraction of the time required by normal ground survey methods since a measurement of upwards of 100 miles is made in a single step. A.

529.781 : 621.317.39

2355. Determination of very small changes in rate over intervals of several days in mechanical timepieces. H. A. BOWMAN. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 218–22 (*Sept.*, 1950).

A device for automatically plotting the isochronism of a clock or watch is described. It was developed to assist in precision tests on marine chronometers and watches, but it may be altered without difficulty to plot the curves for any timepiece. Its accuracy is 0·01 sec, which is sufficient for ordinary timepieces, but by a few simple changes this accuracy may be increased. Some of the curves plotted by this instrument are shown. The sensitivity of this instrument, as well as its graphic scale, may be varied depending upon the quality of the timepiece being tested. A.

PHYSICS 53

53.081.6

2356. A re-evaluation of the fundamental atomic constants. J. A. BEARDEN AND H. M. WATTS. *Phys. Rev.*, **81**, 73–81 (*Jan.* 1, 1951).

A completely new evaluation by the method of least squares. A number of new and highly precise experiments have been taken into account, including the measurement of: the velocity of light by an exceptionally ingenious and precise method due to Hansen and Bol, the absolute proton moment, the ratio of magnetic moments of proton and electron, the proton moment in Bohr magnetons, the hyperfine structure separation of ground-state hydrogen, the ratio of cyclotron to precession frequency of the proton, h/mc using annihilation radiation, and h/e from the X-ray high-frequency limit with improved precision. The results of the critical survey of Dorsey on the velocity of light plus the more recent measurements of c are combined to obtain a weighted-mean value: $c = 299\,790{\cdot}0 \pm 0{\cdot}7$ km/sec. The results of the experiments listed above have been combined by several writers to compute α, e/m, and F. All of the published values, including those of certain older experiments, have been corrected for the new value of c and combined in a least-squares calculation. The results are presented in a complete table of the fundamental constants and are compared with the experimental values in an isometric consistency chart. Six of the experimental results: F, N, mN, α, e/m and h/e, are found to show excellent agreement with the least-squares values. In particular the new experimental value of $h/e = (1{\cdot}37928 \pm 0{\cdot}00004) \times 10^{17}$ erg sec/esu which precipitated the present work agrees well with the least-squares value, $h/e = (1{\cdot}379300 \pm 0{\cdot}000016) \times 10^{-17}$ erg-sec/esu. A.

53.081.6 : 537.531

2357. A new evaluation of h/e by X-rays. J. A. BEARDEN, F. T. JOHNSON AND H. M. WATTS. *Phys. Rev.*, **81**, 70–2 (*Jan.* 1, 1951).

In previous evaluations of h/e by X-rays [Abstr. 1084 (1951)] the correction for the work function of the cathode has been the principal source of error. New experiments have been performed with a technique which eliminates this error and proves conclusively that in the usual X-ray method a correction for the cathode work function must be made. It is also shown that the separation of the fine structure peaks from the cut-off point of the high-frequency limit is a function of the voltage applied to the X-ray tube. The value of h/e computed with the new velocity of light is $(1{\cdot}37928 \pm 0{\cdot}00004) \times 10^{-17}$ erg sec esu^{-1}. A.

53.081.6 : 539.15

2358. Planck's constant and the fine-structure constant. L. L. WHYTE. Letter in *Nature, Lond.*, **166**, 824–5 (*Nov.* 11, 1950).

53.087.6 : 621.395.625.3

2359. Magnetic tape recorder for very low frequency phenomena. P. E. GREEN, JR. *Rev. Sci. Instrum.*, **21**, 893–5 (*Nov.*, 1950).

An apparatus is described for the recording of electrical signals of frequencies below 100 c/s on magnetic tape for subsequent playback. A system of wide deviation frequency modulation of an audio frequency carrier has been employed to eliminate the difficulties normally encountered in the direct recording of l.f. and d.c. signals. A.

FUNDAMENTALS 530.1

530.12

2360. The new Einstein theory and the equations of motion. L. INFELD. Letter in *Nature, Lond.*, **166**, 1075 (*Dec.* 23, 1950).

It is stated that, in the first approximation, the new theory gives Newtonian equations of motion independent of the electromagnetic field. This negative result may arise from certain conventional interpretations of the theory used in deriving the result.

R. A. NEWING

530.12

2361. Equations of motion in general relativity. A. PAPAPETROU. *Proc. Phys. Soc., Lond., A*, **64**, 57–75 (*Jan.*, 1951).

This paper contains a new derivation of the equations of motion of bodies moving slowly in their (weak) gravitational field, up to terms of the order $(v/c)^2$. In contrast to the method developed previously by Einstein and co-workers, in which only the field outside the bodies has been considered, in the present paper a new method is used in which the field outside as well as inside the bodies, and the internal structure of the bodies, is taken into consideration. The equations of motion derived by this new method are identical with those obtained by Einstein and co-workers, but the new method is essentially simpler and the necessary calculations much less lengthy. A.

530.12

2362. Space-time on the rotating disc. B. KURŞUNOĞLU. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 177–89 (*Jan.*, 1951).

The metric of an observer at rest on a rotating disk

is obtained from the field equations of general relativity, without specifying the mechanical properties of the material of the disk. Various ways of measuring distance in general relativity are then discussed and applied to this metric with the conclusion that for an observer on a rotating disk the use of curved space-time is unavoidable. W. J. SWIATECKI

530.145

2363. Formal integration of the equations of quantum theory in the Heisenberg representation. G. KÄLLÉN. *Ark. Fys.*, **2**, *Paper* 37, 371–410 (1950).

It is first shown that the commutator formulae of Schwinger and the *P*-symbols of Dyson satisfy the recurrence formulae in the Heisenberg representation, and the explicit calculations needed are at least not more complicated than before. This method of integration, however, has the disadvantage of not avoiding the complications involved in the normals of the space-like surfaces, as an explicit use of the interaction Hamiltonian has to be made. The real advantage of the Heisenberg representation is thus lost. In the second part the differential equations are therefore solved directly by being substituted into themselves. The theory for particles of integer spin is also investigated, and the similarity to the case of spin $\frac{1}{2}$ is stressed. The removal of a special form of indeterminacy in the theory is illustrated. A.

530.145

2364. Relativistic quantum theory for finite time intervals. E. C. G. STUECKELBERG. *Phys. Rev.*, **81**, 130–3 (*Jan.* 1, 1951).

If transition probabilities are evaluated for transitions occurring during a finite time interval, additional divergencies occur different from those commonly encountered for infinite time intervals. The expressions obtained can, however, be made convergent, if an indeterminacy of time is attributed to each epoch of observation. The method is applied to the emission of a photon by a free electron. A.

530.145

2365. Evaluation of derivatives of fundamental functions. KH. L. SMOLITSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 205–8 (1950) *In Russian.*

Mathematical. If v_m is an orthonormal system of such functions satisfying $(\Delta + \lambda^2)v = 0$, the conditions for $|D^k v_m| < A_k \lambda^{p_k}$ are sought. Here $\Delta =$ Laplacian, $D^k = k^{th}$ derivative, $A_k =$ constants depending on the domain of validity, $p_k > 0$. The results established for $n =$ 3-dimensional space extend to $n > 3$. J. JACOBS

530.145

2366. On the invariant construction of a quantum field theory. N. N. BOGOLYUBOV, V. L. BONCH-BRUEVICH AND B. V. MEDVEDEV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 681–4 (1950) *In Russian.*

With the method of repeated quantization the conditions which relativistic invariance imposes on any quantum field theory are investigated. Additional exclusion principles are avoided. 2 fundamental equations are obtained from which the form of all possible Hamiltonians follows. The general solution is as simple only for a free field. J. JACOBS

530.145

2367. Quantum theory of non-local fields. II. Irreducible fields and their interaction. H. YUKAWA. *Phys. Rev.*, **80**, 1047–52 (*Dec.* 15, 1950).

General properties of non-local operators are considered in connection with the problem of invariance with respect to the group of inhomogeneous Lorentz transformations. It is shown that irreducible fields can be classified by the eigenvalues of 4 invariant quantities. Three of these quantities can be interpreted, respectively, as the mass, radius and magnitude of the internal angular momentum of the particles associated with the quantized non-local field in question. Further, space-time displacement operators are introduced as a particular kind of non-local operator. As a tentative method of dealing with the interaction of non-local fields, an invariant matrix is defined by the space-time integral of a certain invariant operator, which is a sum of products of non-local field operators and displacement operators. It is shown that the matrix thus constructed satisfies the requirements that it be unitary and invariant and that the matrix elements are different from zero only if the initial and final states had the same energy and momentum. However, the remaining conditions of correspondence and convergence cannot be fulfilled simultaneously, in general, by the *S*-matrix for the non-local fields. It is yet to be investigated whether all of these requirements are satisfied by an appropriate change in the definition of the *S*-matrix. A.

530.145

2368. On relativistic symmetry in the non-super-quantized formalism. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci., Paris*, **231**, 1423–5 (*Dec.* 18, 1950) *In French.*

A generalized definition of hermitean product and the characteristic function defined by Arnous lead to a highly symmetric formalism. G. J. KYNCH

530.145

2369. A new meaning for gauge transformations in electrodynamics. P. A. M. DIRAC. *Nuovo Cim.*, **7**, 925–38 (*Nov.*, 1950).

The dynamical theory of the electromagnetic field in interaction with the Pauli–Weisskopf field is worked out with the states defined on general space-like surfaces in space-time. A method is used which allows general gauge transformations $A_\mu \rightarrow A_\mu + \partial S/\partial x^\mu$ with the function S arbitrary. A new assumption is then introduced which connects the gauge with the surfaces on which the states are defined. The Hamiltonian takes on a simplified form, in which the interaction terms are of quite a different type from the usual theory. A.

530.145

2370. On the self-energies of quantum field theory. G. SNOW AND H. S. SNYDER. *Phys. Rev.*, **80**, 987–9 (*Dec.* 15, 1950).

It is shown that by a means of a canonical transformation in quantum electrodynamics, the photon self-energy and the current associated with a mixture of zero-photon and one-photon states cannot be simultaneously made to vanish to order e^2. This difficulty can be overcome by adding a charged Bose meson field. A.

530.145

2371. Boson current corrections to second order. D. C. PEASLEE. *Phys. Rev.*, **81**, 94–106 (*Jan.* 1, 1951).

The β-matrix formalism is applied to the Schwinger–Tomonaga method of calculating 2nd-order current corrections for particles with spin 0 or 1 in interaction with the electromagnetic field. A rule for eliminating the troublesome "surface terms" is introduced, which makes the general formalism exactly similar to that for the electron. One other complication is the appearance in the results of an operator M which has no counterpart in the electron case; this operator can be handled without difficulty, however. The 2nd-order current corrections are found to diverge logarithmically for the vector meson, including the corrections to the dipole and quadrupole moments. For the scalar meson, on the other hand, the divergent terms vanish identically because of special relations between the operators. Thus to this order of calculation, the scalar meson like the electron requires only renormalization of the charge and mass, while the same is no longer true of the vector meson. A.

530.145

2372. Infinite integrals in quantum electrodynamics. D. C. PEASLEE. *Phys. Rev.*, **81**, 107–9 (*Jan.* 1, 1951).

A numerical discrepancy in the results of various authors for the same divergent calculation is traced to differences in the treatment of divergent integrals. The difference is exhibited explicitly, and a standard convention suggested that corresponds to the regularization procedure of Pauli and Villars. Alternative methods of evaluation are criticized on this basis. A.

530.145 : 538.3

On the elimination of divergencies from classical electrodynamics. *See Abstr.* 2482

530.145

2373. On the meaning of the D_c-function in the quantum theory of wave-fields. M. FIERZ. *Helv. Phys. Acta*, **23** (*No.* 6–7) 731–9 (1950) *In German.*

The occurrence of the Stueckelberg–Feynman D-function is interpreted physically. The Heisenberg theory is then outlined and considered in the same terms. G. J. KYNCH

530.145

2374. Selection rules for closed loop processes. C. B. VAN WYK. Letter in *Phys. Rev.*, **80**, 487–8 (*Nov.* 1, 1950).

For a nucleon field interacting with charged and neutral boson fields, a Feynman graph containing a nucleon loop is cancelled by the interchange proton (neutron) = antineutron (antiproton), if, on this loop, the sum of the number of Dirac interaction matrices "odd" with respect to transposition and the number of neutral boson interactions is odd. For neutral boson fields alone, a direct generalization of Furry's theorem forbids reversible loops with an odd number of odd Dirac matrices. R. H. DALITZ

530.145

2375. Transformation properties of spin $\frac{1}{2}$ fields. A. GAMBA. *Nuovo Cim.*, **7**, 919–24 (*Nov.*, 1950) *In Italian.*

Generalizing a suggestion by Yang and Tiomno, the existence of 16 different types of fields of spin $\frac{1}{2}$ is pointed out with reference to the transformation properties under a general inversion of space-time co-ordinates. The possibility of a universal Fermi-type interaction is discussed. A.

530.145

2376. Scattering of mesons by nuclear particles. VACHASPATI. *Phys. Rev.*, **80**, 973–6 (*Dec.* 15, 1950).

Cross-sections for the scattering of mesons by nuclear particles are obtained quantum-mechanically on the basis of the Heitler–Peng version of the perturbation theory. The integral equation taking account of radiation damping in the quantum theory is solved in the classical approximation ($\hbar \to 0$). A comparison of these cross-sections with those obtained classically reveals certain discrepancies. It is found that though the cross-sections calculated classically and those calculated quantum-mechanically in the classical approximation ($\hbar \to 0$) broadly agree in most cases, usually one finds that some higher-order terms which occur in the purely classical treatment are absent in the quantum-mechanical one. The discrepancy is further accentuated in the case of g_2-scattering where the differential cross-sections have generally very different angular dependences and differ from each other in numerical coefficients also. These differences are, in general, such that they cannot be accounted for by postulating quantized orientations of the spin. The correspondence obtained between the classical methods and quantum mechanics by tending $\hbar$ to zero in the results obtained from the latter thus provides a test of the correctness of our theories, and, in the present case it suggests, assuming the classical theory as given by Dirac and Bhabha to be correct, the lines along which a new theory of radiation damping may be developed. A.

530.145

2377. Corrigendum: Interaction between four half-spin particles and the decay of the μ-meson. L. MICHEL. *Proc. Phys. Soc., Lond., A*, **63**, 1371 (*Dec.*, 1950). See Abstr. 5516 (1950).

530.145 : 537.13

2378. On bound states and scattering in positron theory. W. H. FURRY. *Phys. Rev.*, **81**, 115–24 (*Jan.* 1, 1951).

The use of bound state wave functions in calculations in positron theory is justified by the introduction of a new representation, in a certain sense intermediate between the Heisenberg and interaction representations. In the bound-state representation the definition of a stable vacuum state is possible only for a restricted class of external fields. Some attention is given to the problem of vacuum polarization, and it is shown that a very simple procedure accomplishes the charge renormalization with sufficient accuracy to be of use in certain scattering problems. The application to the scattering of radiation is discussed in some detail, in order to show the relation between the different points of view that may be adopted in problems of the coherent scattering by a bound electron and the "Delbrück scattering" by virtual electron pairs. A.

530.145 : 539.185 : 537.133

2379. On the magnetic moments of the proton and neutron. R. K. WANGSNESS. Letter in *Phys. Rev.*, **80**, 769 (*Nov.* 15, 1950).

530.145

2380. The Fourier transformation of Dirac's equation. G. RIDEAU. *C.R. Acad. Sci., Paris*, **231**, 1286–8 (*Dec.* 6, 1950) *In French.*

530.145

2381. On the pseudoscalar symmetrical meson theory of nuclear forces. K.-G. FOGEL. *Comment. Phys.-Math. Helsingfors*, **14** (*No.* 13) 31 *pp.* (1950).

The pseudoscalar symmetrical meson theory has been investigated in a non-relativistic approximation. A zero cut-off has been used. It has been shown that for meson masses less than 355 m_e the theory does not fit experimental results in regard to the low-energy neutron-proton scattering, the binding energy of the deuteron and the quadrupole moment. The high-energy neutron-proton scattering has been investigated in the Born approximation. A strong backward scattering was found. The anisotropy factor $I(\pi)/I(\pi/2)$ approaches infinity as the neutron energy increases. The numerical values for the total scattering cross-section do not agree with the experimental results. The cross-section for high-energy neutron-proton scattering has been calculated from the theories of Møller–Rosenfeld and Møller–Rosenfeld–Schwinger, giving values not in agreement with experimental data. These values are closer to experimental results than those obtained from the pseudoscalar symmetrical theory. A.

530.145

2382. Generalized potentials in the theory of spin-one particles in presence of sources, and the fundamental difficulty of meson theory. B. KWAL. *C.R. Acad. Sci., Paris*, **231**, 37–8 (*Jan.* 3, 1951) *In French.*

A Lagrangean function involving potentials P_i, P_{jk} [Abstr. 5257 (1947)] is given, which leads to the Proca field equations (with sources) for the spin-one meson fields a_i, h_{jk}, now defined in terms of P_i, P_{jk}. However, the interaction term in the Hamiltonian now differs from that of the usual theory, and the potential energy between two sources no longer has any singularities more severe than $1/r$. R. H. DALITZ

530.145

2383. A variational principle for time-dependent problems. M. CINI AND L. A. RADICATI. *Nuovo Cim.*, **7**, 905–10 (*Nov.*, 1950) *In Italian.*

The variational method developed by Schwinger for the treatment of scattering problems has been extended to include the case of a time-dependent potential. The transition amplitude from an initial to an arbitrary final state is shown to be stationary. The time-independent case follows easily from this more general principle. A.

530.145

2384. Some variational-principle relationships connected with the Feynman and Schwinger formulations of electrodynamics. M. CINI. *Nuovo Cim.*, **7**, 911–18 (*Nov.*, 1950) *In Italian.*

Relationships between a variational principle for the transition probability amplitude of a system under the action of a time-dependent potential, and the variational principle established by Schwinger for the "reaction operator K," are studied. Some results already obtained by Dyson concerning the meaning of Feynman's method as an S-matrix method, and the relationship between Feynman's and Schwinger's formulations of quantum electrodynamics, are found in a different way. In the case of a time-independent potential both methods give Schwinger's variational principle for "scattering amplitudes" already extensively used for phase-shift determination in scattering problems. A.

530.145

2385. Some remarks on non-local field theory. D. R. YENNIE. *Phys. Rev.*, **80**, 1053–61 (*Dec.* 15, 1950).

The S-matrix formalism introduced by Yukawa for non-local field theory is considered. For suitable types of non-local fields and interactions it is shown that the S-matrix is convergent through the 2nd order of interaction. In the limiting case in which the non-local fields become local, it is found that the S-matrix formalism yields results inconsistent with the usual formalism unless a certain limiting process is introduced. The limiting process brings agreement between the two formalisms only through the 2nd order of interaction; and the higher orders will, in general, disagree. Unfortunately, the limiting process also destroys the convergence of the S-matrix in the general case of non-local fields. These results suggest that the S-matrix formalism will need to be revised, but no definite recommendations for doing this are made here. An internal angular momentum operator for non-local fields is introduced; this operator aids in the decomposition of the field into irreducible parts of different spins. A.

530.145

2386. On the adiabatic theorem of quantum mechanics. T. KATO. *J. Phys. Soc. Japan*, **5**, 435–9 (*Nov.–Dec.*, 1950).

The adiabatic theorem on the state of a system with a slowly varying Hamiltonian $H(t)$ [see Born and Fock, *Phys. Z.*, **51**, 165 (1928)] is proved when the spectrum of $H(t)$ involves either degeneracy or a continuous range of eigenvalues. The method used consists, for a given eigenvalue or set of eigenvalues, in deriving a unitary operator W which transforms eigenfunction of $H(o)$ into that of $H(t)$ (eigenfunctions if there is degeneracy). W also has the property that it is the limit, for infinitely slow variation, of the correct operator V describing the time variation of the state. G. J. KYNCH

530.145

2387. Field equations, equations of motion and wave-functions. I. A. GIÃO. *J. Phys. Radium*, **12**, 31–40 (*Jan.*, 1951) *In French.*

After the derivation of the field equations in the author's unitary field theory [Abstr. 2328 (1949), 694 (1950)] has been sketched, equations of motion are deduced for the elementary fluids (matter and electricity), and 2 tensors of 2nd order are shown to be conserved. Radiation reaction and forces dependent on spin and on field inhomogeneities appear in the transition from a theory of infinitesimal particles to particles of finite charge and mass. R. H. DALITZ

530.145

2388. New definition of the hermiticity of the operator—$(h/2\pi i)\partial^k$. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci., Paris*, **232**, 214–16 (*Jan.* 15, 1951) *In French.*

The definition and proof of its properties depend on the definitions of hermitean product developed earlier [Abstr. 226 (1948)]. A similar definition has not yet been found possible for particles of spin other than $\frac{1}{2}$. G. J. KYNCH

530.145

2389. Comparison of the spectra of the operators H_t and—$(h/2\pi i)(\partial/\partial t)$. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci., Paris*, **232**, 308–10 (*Jan.* 22, 1951) *In French.*

A physical discussion is given of the characteristics of the spectrum of the operator $i\hbar\partial/\partial t$ defined earlier (see preceding Abstr.), and of its comparison with the spectrum of the Hamiltonian. R. H. DALITZ

530.145.6

2390. Emission principle. A. G. SVESHNIKOV. *Dokl. Akad. Nauk, SSSR*, 73 (*No.* 5) 917–20 (1950) *In Russian.*

The solution of the wave equation in the region between 2 || planes with zero boundary conditions is investigated. A single solution which corresponds to diverging waves is obtained by application of the emission principle in the form of a limiting amplitude or limiting absorption. Analytical conditions at ∞ are analogous to Sommerfeld's. The principle of limiting absorption is applicable also to diffraction problems and thus represents a general emission principle. J. JACOBS

530.145.6

2391. Methods of calculation of radial wave functions and new tables of Coulomb functions. I. BLOCH, M. H. HULL, JR., A. A. BROYLES, W. G. BOURICIUS, B. E. FREEMAN AND G. BREIT. *Phys. Rev.*, **80**, 553–60 (*Nov.* 15, 1950).

In connection with the tabulation of Coulomb wave functions special methods of obtaining numerical results having an accuracy of about 1% have been developed and are reported. Some of the methods are applicable also to other problems. Many of them are concerned with the calculation of the 2nd solution of an ordinary differential equation of 2nd order making use of the 1st solution. The present paper contains an introduction to the use of new Coulomb functions tables which cover ranges of parameters required for the calculation of nuclear reactions of protons, deuterons and alpha-particles from H to O in the energy range of a few MeV. The ranges covered are 0 to 6 for ρ, 0 to 3·98 for η. For alpha-particles the tables suffice for the treatment of reactions up to about 10 MeV for $Z = 9$(F) and 5 MeV for $Z = 2$(He). For protons the tables cover an energy range of roughly 4 times that for alpha-particles. Copies of the tables may be obtained by writing G. Breit, Yale University, New Haven, Connecticut. A.

530.145.6

2392. Asymptotic expansion of the irregular Coulomb function. G. BREIT AND M. H. HULL, JR. *Phys. Rev.*, **80**, 561–3 (*Nov.* 15, 1950).

See preceding Abstr. It is shown that the irregular Coulomb function G_L can be expanded as an asymptotic power series in the energy, with coefficients which are expressible in terms of the modified Bessel function of the second kind. The form of the coefficients is the same as obtained by Yost, Wheeler and Breit in an expansion of the regular function F_L with the modified Bessel function of the second kind replacing that of the first kind of the same order. A.

530.145.6

2393. Singular potentials. K. M. CASE. *Phys. Rev.*, **80**, 797–806 (*Dec.* 1, 1950).

The difficulties arising in quantum mechanics when the potential is highly singular are considered. It is found that the Hamiltonian needs further specification in such cases. This may be done conveniently by requiring a fixed phase for the wave functions at the origin. A proof that all the well-known singular examples are amenable to this treatment is given. For illustration the spectra for spin zero and one-half particles in the fields of highly charged nuclei are found. It is also shown that a complete set of eigenfunctions for a vector particle in a Coulomb field can be found. A.

530.145.6

2394. The virial theorem and the variation principle. I. ISENBERG. Letter in *Phys. Rev.*, **80**, 917 (*Dec.* 1, 1950).

See Abstr. 91 (1951). Acknowledgment of priority.

530.162

2395. On the uncertainty relation. L. CASTOLDI. *Nuovo Cim.*, **7**, 961–2 (*Nov.*, 1950) *In Italian.*

A simple derivation is given of Schrödinger's generalized formulation of the uncertainty relations. L. PINCHERLE

530.162

2396. On the fluctuations in a linear system with periodically-varying parameters. S. I. BOROVITSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 233–6 (1950) *In Russian.*

An account of the theoretical investigation of the fluctuations in systems with periodically-varying parameters using Einstein–Fokker formula. Conclusions from the theory are illustrated by experimental results. Z. F. WOJNAR

530.162

2397. Statistical mechanics and partitions into non-integral powers of integers. B. K. AGARWALA AND F. C. AULUCK. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 207–16 (1951).

Reference is made to the physical approach to the partition theory by Auluck and Kothari [Abstr. 2771 (1946)] who studied the properties of quantal statistical assemblies corresponding to the partition functions familiar in the theory of numbers. In the present paper a theromodynamical approach is made to the partition theory, the partition concept being extended to include partitions into non-integral powers of integers. The connection between thermodynamics and partition theory is given by Bethe's theorem [*Rev. Mod. Phys.*, **9**, 69–244 (*April*, 1937)]. T. C. TOYE

530.162

2398. The condensation of a perfect Bose–Einstein gas. I. A. R. Fraser. *Phil. Mag.*, **42**, 156–64 (*Feb.*, 1951).

Schubert and others have drawn attention to the fact that the standard derivations of the formulae for the behaviour of a perfect Bose–Einstein gas are invalid in the region where condensation should occur. In this paper a new and rigorous derivation is given of formulae for the macroscopic behaviour of such a gas. A.

530.162

2399. The condensation of a perfect Bose–Einstein gas. II. A. R. Fraser. *Phil. Mag.*, **42**, 165–75 (*Feb.*, 1951).

In part I formulae were given for the macroscopic behaviour of a perfect Bose–Einstein gas. They are now given for the mean occupation numbers of the energy levels and for the fluctuations in these numbers. These formulae are in agreement with those obtained by earlier (invalid) methods. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.1

2400. Parallel and rectilinear spring movements. R. V. Jones. *J. Sci. Instrum.*, **28**, 38–41 (*Feb.*, 1951).

Discusses the design of instrument movements in which the moving member is held by two equal and parallel leaf springs; the member can be moved parallel to itself by pushing it normally to the springs. In a constructed specimen the parallelism was maintained to within $\pm 3{\cdot}5$ sec of arc over 6 mm of travel by a simple method of balancing the springs. Arrangements are described for combining two or more spring systems to develop a rectilinear movement. Performances are quoted for three constructions, the best of which held a straight line within about $\pm 0{\cdot}25\,\mu$ over 5 mm of travel, and $\pm 1\,\mu$ over 10 mm. In some applications spring movements are superior to kinematic slides. A.

531.25

2401. Some notes on the analysis of redundant systems by means of the conception of conservation of energy. T. M. Charlton. *J. Franklin Inst.*, **250**, 543–51 (*Dec.*, 1950).

The principles of the analysis of conservative redundant systems capable of deformation are considered. It is well known that reference both to the conditions for equilibrium and geometrical compatibility is necessary to enable a unique solution to be obtained in a particular case. The setting up of one or other of these conditions in a general case using the concept of energy is discussed with reference to the law of conservation of energy. The use of "complementary energy" for the fulfilment of the conditions for geometrical compatibility is demonstrated. The direct application of the conditions of equilibrium and geometrical compatibility is considered in an appendix. A.

MECHANICAL MEASUREMENTS 531.7

531.715

2402. Measurement of the internal diameters of metallic capillary tubes. C. T. Collett, J. C. Hughes and F. C. Morey. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 283–8 (*Oct.*, 1950).

The uniformity of the internal diameters of some metallic capillary tubes was studied by means of a small thread of mercury, using X-ray technique, following the method of Fisher. Eight tubes out of a group of twelve were selected as suitable for use in an absolute viscosimeter, and flow constants were computed. The tubes studied were about 15 ft long, with an internal diameter of about 0·015 in. Maximum deviation from the average diameter in most cases was about 1·5% or less. A.

531.717 : 536.48

The thickness of the helium film. *See Abstr.* 2629

531.717 : 620.179.15

2403. Thickness gaging by radiation absorption methods. C. W. Clapp and S. Bernstein. *Gen. Elect. Rev.*, **53**, 39–42 (*Nov.*, 1950).

A review is given of some of the techniques now used in gauging where the thickness is measured by the absorption of X-, β- and γ-rays. In regard to X-rays, it is known that their penetrating power increases with anode voltage, but change of anode voltage often produces the same change of detector current as much greater change of thickness of material. The use of X-rays is restricted at the lower end by such errors, and at the greater thicknesses their use is limited by breakdown considerations. A comparator method can be used with twin X-ray beams, using a calibrated wedge in one arm. It is considered that γ-rays are too penetrating for thicknesses below 1 in of steel, and β-rays are preferred. β-rays should be employed for thicknesses up to 0·001 in of steel, both β- and X-rays can be used from 0·001 to 0·05 in, but X-rays have to be used for the thicker sheets up to 2 in of steel. A. C. Whiffin (R)

531.752 : 621.317.39

2404. Electric micro-balance. U. von Brockdorff and K. Kirsch. *Elektrotech. Z.* [*ETZ*] **71**, 611–12 (*Nov.* 15, 1950) *In German.*

A weighing arm and a mirror are attached to the spindle of a coil which can rotate between the poles of a magnet (moving-coil system). Light from a suitable source is reflected from the mirror on to a photocell connected into the grid circuit of an amplifying valve. The object to be weighed is placed at the end of the arm and displaces the coil and mirror. The valve circuit is adjusted so that current now passes through the coil and produces equilibrium between the electrical and the mechanical turning moments. An indicating instrument in the anode circuit is calibrated in terms of mass. Range of 15 μg to 300 mg is covered in different models.

E. H. Dock (R)

531.765 : 621.317.39

2405. Time measurements by the Joergensen–Weibel method. J. H. P. Koot. *Ingenieur*, **62**, O.39–O.43 (*Oct.* 27, 1950) *In Dutch.*

With the Joergensen–Weibel condenser-chrono-

graph small time-intervals can be measured with an accuracy better than 0·2%. A condenser of known capacitance is discharged through an ohmic resistor of known value during the time interval to be measured. This method is suitable both for field measurements and for laboratory tests. Two coils, two photo-cells or two microphones are used as terminals for velocity measurements of artillery-projectiles and of small-arms bullets. To determine the propagation velocity of longitudinal sound-waves in elastic solids, two normal piezo-electric gramophone pick-ups are applied. The purpose of these measurements is to examine dynamical properties of materials, as a relation seems to exist between the velocity of sound waves in the examined solid and the strength and the structure of this material. Apparatus built according to the described principle is more simple in construction and less expensive than the existing normal "counter" chronographs. A.

531.768

2406. Response of accelerometers to transient accelerations. S. LEVY AND W. D. KROLL. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 303–9 (*Oct.*, 1950).

Curves and tables are shown for the response of accelerometers to transient exciting accelerations. Three types of acceleration-time relations are considered. When plotted, they have square, triangular and half sine-wave shapes. The natural periods of the accelerometers for which the computations were made were approximately one, one-third and one-fifth of the duration of the acceleration pulse. The damping coefficients of the accelerometers were 0, 0·4, 0·7 and 1·0 times the critical values. It is indicated that, to obtain an accuracy of better than 5% of the peak acceleration in measuring acceleration pulses having the general characteristics of the triangular or sinusoidal pulses, an accelerometer must have a natural period of about one-third the duration of the acceleration pulse, and a damping constant of about 0·4 to 0·7 of the critical value. A.

531.78 : 541.127

Pressure measurements in detonating gases. *See Abstr.* 3126

531.784

2407. Dynamometer with variable sensitivity. R. CAMOLET. *C.R. Acad. Sci., Paris*, **232**, 301–3 (*Jan.* 22, 1951) *In French.*

The apparatus consists of a hardened steel strip, AB, 109×20×1 mm, in the shape of an arc of a circle of radius 145 mm. A is embedded in a block and the direction of the applied force at B is parallel to the strip at A. The experimental results for the sensitivity, shown graphically, show that the sensitivity decreases as the force increases. Electrical resistance strain gauges at A were used to measure the deformations. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.133 : 541.182.6

2408. Studies of the viscosity and sedimentation of suspensions. II. The viscosity and sedimentation of suspensions of rough powders. S. G. WARD AND R. L. WHITMORE. *Brit. J. Appl. Phys.*, **1**, 325–8 (*Dec.*, 1950).

The viscosity of suspensions of rough methylmethacrylate powders in aqueous solutions is shown to increase at all concentrations as the particle size is reduced. This is explained on the assumption that the individual particles behave as if surrounded by a layer of immobile liquid, held in the irregularities of their surfaces. The thickness of the layer, for a particular material, is independent of the viscosity of the suspending liquid, the concentration of the suspension and the size of the particles above a certain minimum value below which it decreases continuously with particle size. Sedimentation experiments made on suspensions of the same particles confirm these conclusions. A.

532.137 : 541.182.6

2409. Use of coaxial-cylinder viscometers and capillary-tube viscometers for suspensions. G. F. EVESON, R. L. WHITMORE AND S. G. WARD. Letter in *Nature, Lond.*, **166**, 1074 (*Dec.* 23, 1950).

532.5

2410. Some aspects of fluid flow—conference at Leamington Spa, 1950. M. W. THRING. *Brit. J. Appl. Phys.*, **2**, 1–5 (*Jan.*, 1951).

Report of a conference held by the Institute of Physics, October 25–28, 1950. A survey of industrial problems was followed by groups of papers on fundamental problems, techniques and applications of present knowledge and techniques. Five discussion groups dealing with the following subjects met in the afternoon: (1) combined flow of fluids and solids; (2) fundamentals of mixing and flow patterns; (3) flow problems in industries employing high temperature furnaces (steel, glass, etc.); (4) flow problems in the process industries (gas, oil, chemical, etc.); (5) flow problems in the industries based on steam generation (power industries). A.

532.511

2411. The principle of least constraint applied to the dynamics of incompressible fluids. J. DELVAL. *Bull. Acad. Roy. Belge. Cl. Sci.*, **36** (*No.* 8–9) 639–48 (1950) *In French.*

The equations of motion of a perfect fluid and of a viscous incompressible fluid are deduced from Gauss's principle of least constraint. The differential equations for the vorticity are similarly associated with an analogous variational principle. J. G. OLDROYD

532.513

2412. Comments on Truesdell's paper on Bernouilli's theorem for viscous compressible fluids. B. ETKIN AND V. G. SZEBEHELY. Letter in *Phys. Rev.*, **80**, 767 (*Nov.* 15, 1950).

A generalized Bernouilli theorem is established for viscous compressible fluids, which provides a more direct relationship between pressure and velocity than Truesdell's theorem [Abstr. 3814 (1950)].

J. G. OLDROYD

532.516

2413. Calculations and tests on models for water and air bearings. F. GOTTWALD AND R. VIEWEG. *Z. angew. Phys.*, **2** (*No.* 11) 437–43 (1950) *In German.*

A low-frictional conical bearing in which the

lubricant (water or air) is forced by a feed pump through holes into the clearance between bearing and journal is discussed. The flow under simplified conditions is calculated, and in particular the dependence on hole size and on the kinetic energy of the lubricant is considered and shown graphically. Tests were made on two Plexiglass models with 8 holes of 1·0 and 0·2 mm dia. respectively. The results are shown graphically and agree well with the simple theory. The stability of the bearing is discussed. S. WEINTROUB

532.517.2

2414. Slow motion of viscous liquid in a semi-infinite channel. W. R. DEAN. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 127–41 (1951).

Slow steady two-dimensional flow between two parallel semi-infinite plane barriers is investigated by making use of a conformal transformation of the region of flow. A stream function is determined which satisfies the condition that the boundaries are streamlines exactly, and the condition of no slip at the boundaries approximately. Expressions are found for the fall in pressure along the central line of the channel, and for the stream function near the sharp edges of the barriers and at large distances from the entrance to the channel. J. G. OLDROYD

532.525

2415. On the standing varicose and sinuous ripple of a cylindrical flow. Y. WADA. *J. Phys. Soc. Japan*, **5**, 439–42 (*Nov.–Dec.*, 1950).

An obstacle in the free surface of a cylindrical jet of fluid causes ripples upstream of the obstacle. The various possible types of standing wave are investigated theoretically, without assuming axial symmetry. There is experimental confirmation of the possibility of a sinusoidal vibration of the jet, with a wavelength increasing as the velocity of flow decreases.

J. G. OLDROYD

532.525

2416. A particular study of certain jets. L. ESCANDE. *C.R. Acad. Sci., Paris*, **231**, 1421–3 (*Dec.* 18, 1950) *In French.*

The entrainment of air by a jet of liquid directed upwards at an angle causes spreading of the jet, coupled with increasing irregularity of its surface. But the mean path is approximately the theoretical parabolic trajectory of a particle projected with the same velocity. J. G. OLDROYD

532.56

2417. The unsteady flow of viscous incompressible fluid inside an infinite channel. L. SOWERBY. *Phil. Mag.*, **42**, 176–87 (*Feb.*, 1951).

The problem considered is the motion of viscous incompressible fluid inside an infinite wedge-shaped channel of angle π/n, the channel being started suddenly from rest with uniform velocity in the direction of its length. The solution is obtained by considering a suitable Green's function for the heat conduction equation. The velocity is found to be expressible either in terms of error functions or in the form of integrals which are suitable for computation, depending on the value of n. Particular reference is made to the right-angled channel ($n = 2$), the results being extended, by Rayleigh's hypothesis, to include some discussion of the steady flow inside a right-angled channel. From this, also, an approximation is derived for the frictional force on the interior of a finite rectangular channel. A.

532.582.81

2418. The general motion of a sphere in a viscous liquid. M. P. DRAZIN. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 142–5 (1951).

A concise method of deriving the formulae of Stokes and Garstang for the force and couple on a sphere which has both translational and rotational motion. J. G. OLDROYD

532.593

2419. On the application of an electromagnetic device for the measurement of the characteristics of the surging sea. C. BOIS. *C.R. Acad. Sci., Paris*, **231**, 1255–7 (*Nov.* 27, 1950) *In French.*

In a way similar to the application of Galitzin's electromagnetic principle for the registration of earthquakes, the new device described by the author serves to record reliably pressure variations of the sea: photographic records of galvanometer deflections are obtained via a special manometer, described by J. Valembois (Grenoble, 1949), or via suitably adopted tidal gauges. A. BEER

CAPILLARITY 532.6

532.61 : 532.133

2420. On certain properties of the force exerted on a surface in contact with a viscous fluid. R. BERKER. *C.R. Acad. Sci., Paris*, **232**, 148–9 (*Jan.* 8, 1951) *In French.*

The tangential stress at a wall is equal to twice the viscosity coefficient times the local vorticity vector, turned through a right-angle in a positive sense about the outward-drawn normal. J. G. OLDROYD

532.612.4

2421. Investigation of the temperature dependence of the surface tension of water. L. D. VOLYAK. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 307–10 (1950) *In Russian.*

Results are given of measurements of the surface tension of H_2O within the temperature range 20°–354°C, using the method of 2 capillary tubes. Silica apparatus was used at higher temperatures. It was found that the results obtained for the temperature range 250°–355°C tallied with van der Waals' formula $\sigma = kT_c^{\frac{1}{3}} p_c^{\frac{2}{3}}(1 - T/T_c)^{1\cdot19}$, where $p_c = 217$ atm, $T_c = 647\cdot3°$, and $k = 0\cdot60$. The same formula can be used for the interval 355°–374°C. It follows that water is practically non-associated above 250°C. By using Eötvös' equation $\sigma(xM/D)^{\frac{2}{3}} = 2\cdot12(T_c - T - \delta)$, the degree of association of water (x) was evaluated for the interval 0–320°C. The empirical formula of Bachinskii $\sigma = c(D - d)^4$ (D = density of the liquid, d = vapour density) gives $c \simeq 70$ for the range 50°–300°C.

F. LACHMAN

532.612.4 : 532.613

2422. The influence of pressure and temperature on the surface tension of crude oil. M. M. KUSAKOV, N. M. LUBMAN AND A. YU. KOSHEVNIK. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 319–22 (1950) *In Russian.*

The surface (air-liquid) and interfacial (liquid-water) tension of C_6H_6, *n*-octane, a non-polar oil, and crude oil samples from 4 sites, were measured by the method of drop size, and by the method of maximum pressure. It was found that, at 20°C, the surface tension of crude oil practically does not change with pressure, and that, under atmospheric pressure, the water/crude-oil interfacial tension does not depend on temperature. F. LACHMAN

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 534.321.9

2423. Acceleration [in the attainment] of the distribution according to the Nernst distribution law by ultrasonic waves. R. HAUL, H. H. RUST AND J. LÜTZOW. *Naturwissenschaften*, **37** (*No.* 22) 523–4 (1950) *In German.*

The extraction of phenanthrene dissolved in methanol saturated with petrol by petrol saturated with methanol, in a wash bottle, is accelerated up to 76% by ultrasonic waves of 570 kc/s. H. LONDON

532.71

2424. The theory of ionic solutions. J. E. MAYER. *J. Chem. Phys.*, **18**, 1426–36 (*Nov.*, 1950).

The virial development for the osmotic pressure of a solution may be used, if the potentials of average force of the solute molecules at infinite dilution are known, to compute the deviations from perfect solution behaviour. The expression for the logarithm of the activity coefficient can thus be obtained as a sum of coefficients multiplied by powers of the concentration. For an ionic solution, with $1/R^2$ forces, the series is only conditionally convergent. By summing certain additive terms occurring in the coefficients over all powers of concentration convergence can be attained. The integrations necessary to obtain terms correct up to and including $c^{\frac{3}{2}}$ are performed. The results are given in terms of certain functions which can readily be computed. A.

532.72

2425. Determination of the autodiffusion coefficient of mercury by the method of isotope exchange. M. HAÏSSINSKY AND M. COTTIN. *J. Phys. Radium*, **11**, 611–14 (*Nov.*, 1950) *In French.*

The autodiffusion coefficient of liquid Hg at 20°C approximates 7×10^{-8} cm²/sec. The energy of activation of the process is 3 100 cal/gram-atom. Both values differ considerably from theoretical values. F. LACHMAN

532.72 : 545.844

2426. The admittance concept in the kinetics of chromatography. J. B. ROSEN AND W. E. WINSCHE. *J. Chem. Phys.*, **18**, 1587–92 (*Dec.*, 1950).

Chromatographic processes with linear kinetics can be represented by a system admittance for the case where the influent concentration varies sinusoidally. The admittance has been obtained for a variety of assumed rate-controlling mechanisms and is shown to depend strongly on the type of kinetics obeyed by the system. The results indicate experimental techniques for determining the kinetics of these processes. Representative results obtained with an electronic analogue computer are presented for a case of non-linear kinetics. A.

532.73 : 536.7 : 541.123.7

2427. The statistical thermodynamics of multi-component systems. H. C. LONGUET-HIGGINS. *Proc. Roy. Soc. A*, **205**, 247–69 (*Feb.* 7, 1951).

A new statistical approach to the theory of multi-component systems. A "conformal solution" is defined as one satisfying the following conditions: (1) The mutual potential energy of a molecule of species L_r and one of species L_s at a distance ρ is given by the expression $u_{rs}(\rho) = f_{rs}u_{00}(g_{rs}\rho)$, where u_{00} is the mutual potential energy of two molecules of some reference species L_0 at a distance ρ, and f_{rs} and g_{rs} are constants depending only on the chemical nature of L_r and L_s. (2) If L_0 is taken to be one of the components of the solution, then f_{rs} and g_{rs} are close to unity for every pair of components. (3) The constant g_{rs} equals $\frac{1}{2}(g_{rr} + g_{ss})$. From these assumptions it is possible to calculate rigorously the thermodynamic properties of a conformal solution in terms of those of the components and their interaction constants. The non-ideal free energy of mixing is given by the equation $\Delta^*G = E_0 \sum\sum_{r<s} x_r x_s d_{rs}$, where $E_0 = RT - L_0$ (L_0 the latent heat of vaporization), x_r is the mole fraction of L_r and d_{rs} denotes $2f_{rs} - f_{rr} - f_{ss}$. This equation resembles that defining a regular solution, with the difference that E_0 is a measurable function of T and p, which makes it possible to relate the free energy, entropy, heat and volume of mixing to the thermodynamic properties of the reference species; and the predicted relationships between these quantities agree well with available data on non-polar solutions. The theory can be applied both to liquids and to imperfect gases, and to two-phase two-component systems near the critical point. A.

532.73–1

2428. On the stability of gas bubbles in liquid-gas solutions. P. S. EPSTEIN AND M. S. PLESSET. *J. Chem. Phys.*, **18**, 1505–9 (*Nov.*, 1950).

With the neglect of the translational motion of the bubble, approximate solutions may be found for the rate of solution by diffusion of a gas bubble in an undersaturated liquid-gas solution; approximate solutions are also presented for the rate of growth of a bubble in an oversaturated liquid-gas solution. The effect of surface tension on the diffusion process is also considered. A.

532.739.2

2429. Solubility of iodine in solvent mixtures. G. KORTÜM AND M. KORTÜM-SEILER. *Z. Naturforsch.*, **5a**, 544–55 (*Oct.*, 1950) *In German.*

This paper extends a previously reported investigation [M. Kortüm-Seiler and G. Kortüm, *Z. Elektrochem. angew. phys. Chem.*, **54**, 70 (1950)] and deals with the systems I-*cyclo*hexane-ethylenebromide, I-*cyclo*hexane-methylbutylether, and I-*cyclo*hexane-

dioxan with respect to the relationship of solubility of I to solvent composition and temperature. The properties of the violet I solutions are discussed from the thermodynamic standpoint. The presence of the stoichiometric compounds I_2-ether and I_2-dioxane, has been established with certainty in the *cyclo*hexane-ether and *cyclo*hexane-dioxane mixtures, and their dissociation constants and T-dependence have been determined. Free solution-enthalpy, differential heat of solution, and entropy, have been calculated as functions of the molecular fraction. The kind of bonding of the above compounds is discussed in relation to the polarizability of I. There are 5 tables, 6 curves and 24 references. H. H. HODGSON

532.74

2430. Association of dipolar molecules in liquids and solutions from measurements of the dielectric relaxation period. E. FISCHER. *Z. Naturforsch.*, **5a**, 628–9 (*Nov.*, 1950) *In German.*

Relaxation periods are cited for the pure liquids, and also for their solutions in CCl_4, of C_6H_5Cl and $C_{10}H_7Br$ (unassociated), and of C_6H_5OH, o-$CH_3C_6H_4OH$, o-ClC_6H_4OH, o-OHC_6H_4CHO, o-$NO_2 . C_6H_4OH$, $C_6H_5NO_2$ and C_6H_5CN (associated), which indicate degrees of association of these dipolar molecules at various concentrations. The influence of inner H bonding on the various results is discussed in explanation of anomalies. H. H. HODGSON

532.74 : 534.22.093.3

2431. Ultrasonic measurement of solvation. Y. WADA, S. SHIMBO AND M. ODA. Letter in *J. Acoust. Soc. Amer.*, **22**, 880 (*Nov.*, 1950).

532.74 : 539.133

2432. Molecular association in liquids. I. Molecular association due to lone-pair electrons. J. LENNARD-JONES AND J. A. POPLE. *Proc. Roy. Soc. A*, **205**, 155–62 (*Feb.* 7, 1951).

This paper aims at giving a general survey of the part played by lone-pair electrons in the range of phenomena commonly classified under the heading of molecular association, with particular emphasis on the liquid state. The position of lone-pair electrons on a molecule and the factors determining their availability for forming intermolecular links are discussed in terms of molecular orbital theory. The way in which these association forces influence the structure of large aggregates of molecules as in liquids is examined. The lines along which a quantitative theory of associated liquids may be developed are indicated. A.

532.74 : 539.133

2433. Molecular association in liquids. II. A theory of the structure of water. J. A. POPLE. *Proc. Roy. Soc. A*, **205**, 163–78 (*Feb.* 7, 1951).

Previous theories of the structure of liquid water have either placed undue emphasis on crystalline structures or have postulated that too many H bonds connecting neighbouring molecules are broken. In this paper a theory is developed in which the majority of H bonds are regarded as distorted rather than as broken. The structural changes are examined quantitatively with the aid of a simple expression for the energy of a bent H bond. It is shown that the use of a bending force constant consistent with electrostatic calculations on simple models of water molecules leads to a satisfactory quantitative explanation of the observed radial distribution function, the discontinuity in density associated with the melting of ice, and the observed values of the permittivity of water. A.

MECHANICS OF GASES 533

533.15

2434. Errors in diffusion measurements by the Loschmidt method. L. TORDAI. *Brit. J. Appl. Phys.*, **1**, 329–32 (*Dec.*, 1950).

The problem of obtaining diffusion coefficients of gases with high absolute accuracy is considered. It is shown that the Loschmidt method is capable of giving such results. The conditions which are likely to yield the highest accuracy are established. A.

533.15 : 536.423.15

2435. Some measurements of thermal transpiration. S. C. LIANG. *J. Appl. Phys.*, **22**, 148–53 (*Feb.*, 1951).

Measurements have been made of the pressure ratio, R, due to thermal transpiration in H_2, He, A and N_2 between a warm temperature of 297°K and cold temperatures of 77·3 or 195°K. It is found that R depends on X, the product of the pressure and tube diameter according to the empirical relation, $R = P_1/P_2 = (AX^2 + BX + R_m)/(AX^2 + BX + 1)$, where A and B are constants which depend on the gas and on the warm and cold temperatures, and $R_m = (T_1/T_2)^{\frac{1}{2}}$. The R against P_2, and therefore X, curves for different gases are found to be related by a "pressure shifting factor" f. The use of these results to correct measurements of adsorption equilibrium and vapour pressures at low pressures and low temperatures is discussed. Vapour pressures at 77·3° ± 0·5°K corrected for the thermomolecular pressure effect are: Kr, 1·754 ± 0·002 mm; Xe, 1·93 ± $0{\cdot}01 \times 10^{-3}$ mm. A.

533.15.096

2436. Erratum: Thermal diffusion in the critical region. II. E. B. GILLER, R. B. DUFFIELD AND H. G. DRICKAMER. Letter in *J. Chem. Phys.*, **18**, 1683 (*Dec.*, 1950). See Abstr. 7785 (1950).

533.5

2437. Notes on formulae for the flow of rarefied gases through tubes. L. DUNOYER. *Vide*, **5**, 881–6 (*Nov.*, 1950) *In French.*

It is shown that the mean pressure over the length of a tube cannot be taken as equal to the average of the pressures at the ends. From a modified form of Knudsen's equation it is shown that, for air at 20°c the flow may be assumed to be molecular if the pressure in microns Hg is < 18/(tube dia. in cm), and entirely viscous if the pressure in microns Hg $>$ 462/(tube dia. in cm), the error being $< 10\%$ in each case. A simplified treatment is given for the intermediate region. N. CORCORAN

533.5 : 531.788.7

2438. A reliable Pirani vacuum safety circuit. W. FRANZEN AND J. HORTON. Note in *Rev. Sci. Instrum.*, **21**, 935 (*Nov.*, 1950).

533.5 : 621.317.39

2439. The measurement of high vacuum by electrical methods. I. F. WADE. *Electronic Engng*, **23**, 30–4 (*Jan.*, 1951).

Summarizes the history of the study of the phenomena employed, thermal-conduction and electrical ionization. The Pirani and thermocouple gauges are described and their theory given. Gauges depending upon the length of the Crookes' dark space are briefly described. C. F. BROCKELSBY (R)

533.5 : 621.389

2440. Auxiliary electronic equipment of an ionization vacuum gauge. Č. ŠIMÁNĚ. *Slabopr. Obz.*, **11**, 209–13 (*Nov.*, 1950) *In Czech.*

A description of power supplies, a device for automatic stabilization of the emission current at an adjustable value, a device for measuring the ion current and a protective relay system to safeguard the gauge against damage due to faulty handling and accidental failure of the vacuum system. A.

533.56

2441. The design of molecular pumps. R. B. JACOBS. *J. Appl. Phys.*, **22**, 217–20 (*Feb.*, 1951).

A theoretical treatment is given for the operating characteristics of molecular drag type pumps, based on kinetic theory and limited to high-vacuum operation. The solutions are simple and may be applied readily to practical pump designs. They lead to performance characteristics which are thought to be accurate to $\pm$ 10%. A.

533.6.011

2442. Certain solutions of the equations of plane flow of a fluid under an approximate law of compressibility. R. LEGENDRE. *C.R. Acad. Sci., Paris*, **231**, 1419–21 (*Dec.* 18, 1950) *In French.*

A group of solutions, comprising an arbitrary function and an arbitrary integration contour is found for the isentropic plane-flow potential function of a fluid obeying a law of compressibility passably close to that obeyed by a perfect gas in the sub- and super-sonic domains. The validity and characteristics of the solutions are briefly discussed. J. S. G. THOMAS

533.6.011

2443. Approximately uniform, permanent subsonic, sonic and supersonic flow. D. RIABOUCHINSKY. *C.R. Acad. Sci., Paris*, **232**, 280–3 (*Jan.* 22, 1951) *In French.*

An approximate theory of approximately permanent fluid motion in 2 and 3 dimensions of a perfect compressible fluid is developed under the assumption that departures of local velocities, q, relative to the mean velocity q_1, are so small that squares of the ratio $\varepsilon = (q - q_1)/q_1$ are negligible, and that an approximate adiabatic law in the form $p - p_1 = c_1^2\rho_1(1 - \rho_1/\rho)$ can be used in place of the adiabatic law $c_1^2 = \gamma p_1/\rho_1$. The theory is applied to the discussion of sonic flow along an undulatory surface and within the space bounded by two such surfaces. J. S. G. THOMAS

533.6.011.31

2444. On the surface of discontinuity between two flows perpendicular to each other. H.-C. LU. *Engng Rep. Nat. Tsing Hua Univ.*, **4**, 40–62 (*Oct.*, 1948).

The surface of discontinuity between a parallel flow and a circular jet perpendicular to the former one is investigated in two different ways. The first method is an analytical one and a solution in power series is suggested. The problem is solved in turn by the method of successive approximation. The results from both methods check with actual wind tunnel measurements. A.

533.6.011.31

2445. Experimental measurement of incompressible flow along a cylinder with a conical nose. E. V. LAITONE. *J. Appl. Phys.*, **22**, 63–4 (*Jan.*, 1951).

The experimental pressure distribution data from low-speed wind tunnel tests at zero angle of attack on two different conical noses attached to a cylindrical after-body are compared with theory. The simplified theoretical equation used is a higher order approximation valid up to the order $r^4 \ln r$. It is shown that the conical nose with a vertex angle of 20 degrees is in agreement, but the larger cone with a vertex angle of 30 degrees shows a discrepancy between the measured pressures and the approximate theory. In both cases, however, the theory is in excellent agreement with the surface pressures on the cylindrical after-body. A.

533.6.011.4

2446. Hypersonic flow at a Mach number of 10. I. D. V. FARO, T. R. SMALL AND F. K. HILL. *J. Appl. Phys.*, **22**, 220–2 (*Feb.*, 1951).

Tests designed to produce supersonic streams at 10 and 16 times the local speed of sound are described. In contrast to the usual wind tunnel apparatus, a conical nozzle is used for the expansion section, and the supply pressure is varied throughout a wide range. Some properties of the flow at high Mach numbers are discussed, and, in particular, data is given showing a systematic dependence of Mach number on stagnation pressures, a phenomenon not previously reported. A.

533.6.011.5

2447. Symmetrical conical flow at supersonic speed [studied] by the perturbation method. W.-Z. CHIEN. *Engng Rep. Nat. Tsing Hua Univ.*, **3**, 1–14 (*Dec.*, 1947).

The irrotational flow of non-viscous, compressible fluid past a cone, behind the conical shock wave, has been studied by Kármán and Moore [*J. Appl. Mech.*, **54**, 303 (1932)], Taylor and Maccoll [*Proc. Roy. Soc.*, **139**, 278–311 (1933)] and by Buseman [*Z. angew. Math. Mech.*, **9**, 496 (1929)]. The theoretical results obtained by the two former pairs of authors differ considerably from one another even for cones of small semi-angle 10°; Buseman's solution is no improvement on the Kármán–Moore solution. Hitherto, shock-wave conditions have been neglected. Taking shock-wave conditions into account, and applying the perturbation method to the linearized Kármán–Moore solution as a first approximation, Chien shows that this method gives the pressure increment, the shock-wave position and the flow pattern for a cone of small semi-angle in asymptotic forms, and satisfactory agreement with previous results by carrying the theory to a fifth approximation. This approximation is quite accurate for small conical semi-angles $\leqslant 20°$. J. S. G. THOMAS

533.6.011.5

2448. Supersonic flow in two dimensions along a curved wall. T. DE KÁRMÁN AND J. FABRI. *C.R. Acad. Sci., Paris*, **231**, 1271–4 (*Dec.* 6, 1950) *In French.*

In the supersonic region, it is convenient to consider the perturbation velocities in the x- and y-directions by reference to the uniform sonic flow whose velocity in the x-direction is equal to the critical velocity. Expressions for the flow, in a form suitable for calculation, are obtained. G. F. HODSMAN

533.6.011.5

2449. Compressible supersonic flow in jets under the Kármán–Tsien pressure-volume relation. N. COBURN. *J. Appl. Phys.*, **22**, 124–30 (*Feb.*, 1951).

The 2-dimensional supersonic irrotational flow of a gas in a jet is studied by use of the Kármán–Tsien pressure-volume law. There are two limitations to such a study: (1) since the fluid flow is not continued from the subsonic range, arbitrary boundary conditions must be prescribed; (2) use of the Kármán–Tsien pressure-volume relation implies a restriction on the permissible range of pressure, density and velocity. On the other hand, use of the Kármán–Tsien law furnishes several advantages: (1) the velocity potential and stream function satisfy the wave equation in the hodograph plane and hence these functions can be easily determined; (2) the mappings between the physical and hodograph planes may be completely characterized and studied in detail. This gain in information should be valuable in the qualitative understanding of phenomena as well as in obtaining first approximations to quantitative solutions. In the case of jets, with free stream lines as boundaries, it is shown that two functions possessing certain desired properties completely determine the Kármán–Tsien flow. Further, the phenomenon of the periodic recurrence of the free stream jet boundary is explained by a folding property of the map of the flow in the hodograph plane. A.

533.6.011.5

2450. Density measurements in supersonic flow by means of the X-ray absorption method. E. M. WINKLER. *J. Appl. Phys.*, **22**, 201–2 (*Feb.*, 1951).

The density in supersonic flow was measured by the absorption of soft X-rays. The equipment is briefly described. Data obtained in undisturbed flow at $M = 2{\cdot}83$ are compared with values computed from Pitot pressure measurements. Measurements of the density distribution across a shock wave on a wedge-shaped model are presented. The suitability of the method, its limitations and improvements of the technique are briefly discussed. A.

533.6.011.5 : 534.222.2

2451. The interaction between an oblique shock-wave and a turbulent boundary-layer. O. BARDSLEY AND W. A. MAIR. *Phil. Mag.*, **42**, 29–36 (*Jan.*, 1951).

Schlieren photographs have been taken to show the reflection of oblique shock-waves of different strengths at the turbulent boundary-layer on the wall of a supersonic wind-tunnel. A weak shock-wave is reflected as a compression followed by an expansion; this is in agreement with Lighthill's theory in which the boundary-layer is replaced by a non-turbulent inviscid layer with the same velocity distribution as a turbulent boundary-layer. For stronger incident shock-waves the reflected wave moves upstream of the incident one to a point where the boundary-layer starts to thicken. Thus the incident and reflected shock-waves cross outside the boundary-layer. Near the point where the incident shock-wave meets the boundary-layer, the rate of growth of the boundary-layer suddenly decreases and an expansion occurs. For very strong shock-waves a Mach type of interaction occurs, with a short normal shock-wave between two intersections. The supersonic wind-tunnel and optical system used are briefly described. A.

533.6.011.6

2452. Aerodynamic cooling effects. J. ACKERET. *Ric. Sci.*, **20**, 1926–7 (*Dec.*, 1950).

Eckert measured the temperature on a circular cylinder held across a high-speed airstream and found that near the stagnation line, the temperature is very close to the stagnation temperature and then falls to that calculated for a flat plate, without pressure gradient, by Croco, Hantzsche, Wendt and others, viz. $T_{\text{surface}} = T_0 - \mu^2(1 - \sqrt{\sigma})/2Cp$, where σ is the Prandtl number $= Cp\eta/\lambda$. On the rear side of the cylinder the temperature decreases until a minimum is reached at 180°, the manner of decrease depending on the Mach number of the flow. Eckert's results have been confirmed and similar results have been obtained with half cylinders, elliptic cylinders, steep-angle aero foils, etc. In one case a minimum temperature which was 64% of the free stream stagnation temperature below that of the undisturbed air was found, the body in the stream acting as a refrigerating engine. A low temperature is found in the wake near the obstacle, and outside the wake a higher temperature occurs. It is suggested that the effect referred to is related to the vortex-tube cooling effect discovered by Raneque and studied by Hilsch.

J. S. G. THOMAS

533.6.013.22

2453. The spectrum of turbulence. K. KUZUKAWA. *J. Phys. Soc. Japan*, **5**, 412–16 (*Nov.–Dec.*, 1950).

The theory of the spectrum of turbulent flow, developed by Taylor, Kármán and Howarth, Weizsäcker, and by Heisenberg [Abstr. 4525 (1949)] is considered to be correct only when the vortex discussed is sufficiently larger than the smallest vortex and sufficiently smaller than the largest vortex in the flow. This condition is not satisfied in the customary wind-tunnel flow. The spectrum of turbulent flow is deduced by a quantum-theory method and the distribution function of the energy, in one degree of freedom, is shown to agree well with Taylor's experimental results [*Proc. Roy. Soc.*, *A*, **164**, 476 (1938)]. J. S. G. THOMAS

533.6.013.22

2454. On a correlation problem in a model of turbulence. J. M. BURGERS. *Ric. Sci.*, **20**, 1933–7 (*Dec.*, 1950).

A mathematical problem concerning correlations occurring in the theory of homogeneous turbulence, discussed by Kolmogoroff, Heisenberg, Batchelor [*Proc. Camb. Phil. Soc.*, **43**, 533 (1946)], is treated. Thus, e.g., it is shown by a comparison of the physical dimensions of κ, the modulus of the wave number, ε,

the decay of energy per unit mass in unit time, and ν the kinematic viscosity of the fluid, that the average contribution to the energy per unit mass $E(\kappa)d\kappa$ derived from harmonic components with modulus of the wave number between κ and $\kappa + d\kappa$, is given by $E(\kappa) = \varepsilon^{1/4}\nu^{5/4}F(\kappa\varepsilon^{-1/4}\nu^{3/4})$. The correlation function $\overline{(u - u')}$, introduced by Kolmogoroff, where u and u' are simultaneous values of a component of the velocity at two points at a distance r from each other is given by $\overline{(u - u')^2} = \varepsilon^{1/2}\nu^{1/2}f(r\varepsilon^{1/4}\nu^{-3/4})$. Other correlations based upon Kolmogoroff's theory are briefly discussed. J. S. G. THOMAS

MOLECULAR THEORY OF GASES 533.7

533.7

2455. The temperature dependence of the self-diffusion coefficients of argon, neon, nitrogen, oxygen, carbon dioxide, and methane. E. B. WINN. *Phys. Rev.*, **80**, 1024–7 (*Dec.* 15, 1950).

The self-diffusion coefficients of A, Ne, N_2, O_2, CO_2 and CH_4 have been measured as functions of the temperature: A, Ne, N_2 and O_2 in the range — 196°C to 80°C, CO_2 in the range — 78·5°C to 80°C and CH_4 in the range — 183°C to 80°C. The experimental figures have been compared with values calculated on the assumption that the molecular interaction potential is of the form $V(r) = 4\varepsilon[-(r_0/r)^6 + (r_0/r)^{12}]$. With the exception of the lowest point for CH_4, all figures are in essential agreement with theory. A.

533.75 : 533.24

2456. Gas theory and the equation of state. X. Compressibility of nitrogen and corresponding states. J. DUCLAUX. *J. Phys. Radium*, **11**, 641–5 (*Dec.*, 1950) *In French.*

Previous work [Abstr. 3437 (1947) and 8564 (1950)] is extended to represent the results of Kammerlingh Onnes and van Urk for N_2. Calculated and observed values are compared at — 131·27°C for pressures from 25·29 to 58·31 atmos. Over an extended range the results are summarized as follows: (*a*) for temperatures above — 140°C calculated and observed values are in agreement for volumes greater than twice the critical volume; (*b*) near the critical point the differences are of the order of 0·001 (Amagat units) when the volume is more than $2\,v_c$ and 0·008 for $1{\cdot}5\,v_c$. The theory leads to the idea of iso-condensation, i.e. states where pv_f/RT is the same for a constant value of one parameter. This enables corresponding states between different gases to be defined without reference to the critical constants. It is indicated that the law of condensation (molecular association) assumed requires modification at very high and very low pressures. F. E. HOARE

VIBRATIONS . ACOUSTICS 534

534.014.5 : 513.83

2457. Topological methods in the treatment of problems of non-linear oscillations. T. VOGEL. *Ann. Télécommun.*, **6**, 2–10 (*Jan.*, 1951) *In French.*

The methods of Poincaré, Bendixson and Dulac are explained and applied to equations of the first order and degree in dy/dx and non-linear in y. Several practical examples are given. These include: (1) the equation $x'' + x = \mu f(x, x')$; (2) Van der Pol's equation, $u'' - (1 - 4u^2)u' + \omega^2 u = -F\omega^2 \sin \Omega t$; (3) the equation, $I\phi'' + \varepsilon\phi' + mgl \sin \phi = 0$, which governs the large oscillations of a pendulum in a viscous fluid. L. S. GODDARD

534.131

2458. Vibrations of closed spaces with deformable elastic walls. T. VOGEL. *J. Phys. Radium*, **11**, 627–32 (*Nov.*, 1950) *In French.*

Hypotheses in the simple geometric theory of the acoustics of closed spaces are shown to be at variance with the wave equation in the case where a velocity potential exists. These are explained, using hypotheses analogous to those used in linear elastic theory, the velocity potential being expressed as a series.

G. F. HODSMAN

534.133 : 621.396.611.21

2459. Quartz vibrators. P. VIGOUREUX AND C. F. BOOTH. *London, Department of Scientific and Industrial Research* (1950) 371 *pp.*

A revised and extended version of "Quartz oscillators and resonators," by P. Vigoureux. The properties, occurrence and examination of quartz crystals are described, and the theory and practical details of quartz vibrators developed. Various applications (frequency control, ultrasonic transducers, pressure gauges, etc.) are described in some detail. An entirely new section (70 pages) is devoted to manufacturing methods. (185 figures, 64 plates, bibliography of about 200 entries).

534.14

2460. On parametric excitation. N. MINORSKY. *C.R. Acad. Sci., Paris*, **231**, 1417–19 (*Dec.* 18, 1950) *In French.*

If an appropriate parameter of an oscillatory system (mechanical or electrical) is varied, the system oscillates with a certain frequency. This phenomenon is studied by means of an analysis of the differential equation describing the system. A perturbation method is applied to a Mathieu equation, and the boundedness, or otherwise, of the solution is studied, both when the equation is linear and when it is non-linear. The results agree with experimental data obtained by Mandelshtam and Papaleksi [*J. Tech. Phys., USSR* (1934)].

L. S. GODDARD

534.14

2461. Parametric excitation. N. MINORSKY. *J. Appl. Phys.*, **22**, 49–54 (*Jan.*, 1951).

See preceding Abstr.

534.213

2462. Asymptotic approximation for the normal modes in sound channel wave propagation. N. A. HASKELL. *J. Appl. Phys.*, **22**, 157–68 (*Feb.*, 1951).

Asymptotic methods are used to find approximate solutions of the acoustic wave equation in a medium in which the velocity is a continuously variable function of one co-ordinate. It is shown that, when the velocity function has a minimum, undamped normal mode solutions exist and are closely analogous

to the internally reflected waves in the case of a medium made up of discrete layers. By converting the sum of the high order normal modes into an equivalent integral, it is shown that superposition of these modes leads to geometrical ray theory modified by diffraction in a manner that may be computed from the incomplete Fresnel and Airy integrals. A.

534.22 : 534.321.9

2463. A method of measuring the velocity of propagation of ultrasonic waves in liquids. T. S. VELICHKINA AND I. L. FABELINSKIĬ. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 2) 177–80 (1950) *In Russian.*

The characteristic feature is applicability to measurements on thin layers of viscous liquids; liquids having a viscosity of 100 poises can be investigated up to 2·5 Mc/s and higher viscosities up to a somewhat lower frequency. The basis of the method is that transmission of acoustic waves through a thin layer of material reaches a clearly defined max. at half-wavelength intervals in layer thickness. The liquid is contained between the flat end faces of 2 glass rods whose distance apart can be accurately measured. Ultrasonic waves are passed along one rod and through the liquid; their amplitude in the second rod is recorded either optically or electrically. The dist. between the rods is varied so that the transmitted energy traverses a known no. of maxima (N); from the variation in separation the wavelength can be found, and hence, knowing the frequency, the velocity can be calculated. Results are given for pentane over the range -120 to $+2$°c and for triacetine from -30°c to $+90$°c. For $N = 10$, it is estimated that the error in determination of the wavelength, the main source of error, is 0·3%; for very viscous liquids the accuracy is reduced, as the transmissivity maxima become less sharp.

A. SCHOFIELD

534.22.093.3 : 532.74

Ultrasonic measurement of solvation. *See Abstr.* 2431

534.221 : 534.321.9

2464. Dispersion of ultrasonic velocity in the liquid higher fatty acids. Y. WADA, S. SHIMBO AND M. ODA. Letter in *J. Acoust. Soc. Amer.*, **22**, 880 (*Nov.*, 1950).

534.23

2465. Sound transmission layers. B. D. TARTAKOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 1) 29–32 (1950) *In Russian.*

The article works out algebraically and diagrammatically a solution to the problem of rendering the boundaries of different media fully conductive. An examination of the method of propagation of plane waves through similar layers leads to a study of the conditions under which sound energy is transmitted, without loss, through the boundary separating two different media, between which the sound transmission layers are situated. The formulae advanced are held to prove that, in principle, any medium can be rendered fully conductive by a combination of layers consisting of materials the applicability of which can be tested by means of a graph in which co-ordinates are placed on a logarithmic scale. Graphs are also given illustrating energy conductivity calculation for a given case, and the dependence of conductivity upon angle of incidence. Ernst's conclusions as to the behaviour of certain layers independently of the law of distribution of their wave-resistances are incidentally judged to be erroneous. J. CLEUGH

534.23

2466. Relaxation absorption of elastic vibrations in β-brass near the Curie point. P. E. STEPANOV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 217–20 (1950) *In Russian.*

534.23 : 532.74

2467. On the ultrasonic absorption in binary mixtures of unassociated liquids. D. SETTE. *J. Chem. Phys.*, **18**, 1592–4 (*Dec.*, 1950).

Measurements of absorption coefficient were carried out in a binary mixture formed by two unassociated liquids having similar absorption coefficients. The curve of absorption coefficient *v.* mole fraction has a minimum at an intermediate concentration. A theoretical interpretation of experimental results is presented. A.

534.23 : 541.14

2468. Comment on "Theoretical explanation of the chemical effects of ultrasonics." A. WEISSLER. Letter in *J. Chem. Phys.*, **18**, 1513 (*Nov.*, 1950).

534.23 : 541.182.5

2469. Absorption of ultrasonic waves in gels. I. G. MIKHAĬLOV AND L. I. TARUTINA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 41–4 (1950) *In Russian.*

Diffraction spectra were photographed and intensities determined photometrically. The role of strain viscosity increases rapidly with the solution of the gel. At small concentrations c the measured amplitude coefficient α equals its Stokes' value; for higher c, α increases considerably above it. J. JACOBS

534.231.3.08

2470. Acoustical impedance and absorption coefficients. W. A. HILTON AND L. B. HAM. *Amer. J. Phys.*, **17**, 500–2 (*Nov.*, 1949).

A method for the determination of the normal coefficient of absorption and acoustical impedance of sound-absorbing materials is described. Two impedance tubes are used, both of which are 9 ft in length with square cross-sections and inside areas of 1·0 and 0·25 ft² respectively. Both tubes were constructed of well-seasoned 2 in wood, which was sanded, covered with wood filler and given two coats of shellac. AUTHOR

534.232

2471. An ultrasonic projector design for a wide range of research applications. E. J. FRY. Note in *Rev. Sci. Instrum.*, **21**, 940–1 (*Nov.*, 1950).

534.232 : 537.228.1 : 621.395.62

2472. The design of resonant quartz-crystal ultrasonic transducers for research purposes. G. W. SWANSON, JR. AND W. T. THOMSON. *J. Appl. Mech.*, **17**, 427–30 (*Dec.*, 1950).

The paper is intended to co-ordinate the several approaches to the design problem and to present a practical method for designing quartz-crystal transducers for ultrasonic frequencies. A.

534.232 : 621.395.623.7

2473. A loudspeaker arrangement with unilateral directivity. H. KALUSCHE. *Z. angew. Phys.*, **2** (*No.* 10) 411–15 (1950) *In German.*

By combining a first-order transmitter with an acoustic transit-time element, a heart-shaped radiation diagram can be obtained. Curves are given showing the radiation characteristics of a linear arrangement of six such combinations for frequencies of 100, 200, 500, 1 000, 3 000 and 10 000 c/s and for both the horizontal and the vertical plane. Less than 10% of the sound energy is radiated backwards.

A. WILKINSON (R)

534.232 : 621.395.623.7

2474. Progress in the field of loudspeaker construction and its physical principles. W. BURCK. *Fortschr. Radiotech.* (*Issue No.* 1) 3–24 (1950–51) *In German.*

A review of development with numerous diagrams and photographs.

534.232 : 621.395.623.7.001.4

2475. Transient testing of loudspeakers. M. S. CORRINGTON. *Audio Engng*, **34**, 9–13 (*Aug.*, 1950).

A study of the relationship between the sound-pressure curve of a loudspeaker and the transient response to a suddenly-applied unit sine wave. Based on an assumed sound-pressure response characteristic with peaks at 5 and 10 kc/s only, the pole locations in the complex frequency plane are shown and expressions given for the impedance function, and for the transient response to (1) a unit impulse, (2) a unit sine wave at 5 kc/s, and (3) the same at 10 kc/s. The relative values of the transient components for cases (2) and (3) are discussed and curves shown for the variations of these components with applied frequency and for the responses to such excitations with time. Finally, a conventional 12 in loudspeaker, whose sound-pressure and voice-coil impedance curves are shown, is considered. Photographs show the radial break-up of the cone at specific frequencies in the range 400–1 000 c/s and circular break-up from 1·2 kc/s upwards and are accompanied by oscillograms of the responses to unit sine waves at these frequencies. The relationship between the various frequency components seen in the oscillograms, the build-up, the presence of ringing, the speed of decay, etc., are considered in each case. H. G. M. SPRATT (R)

534.321.9 : 541.132

2476. The measurement of ultrasonic vibration potentials (Debye effect) with pulse techniques. E. YEAGER, J. BUGOSH AND F. HOVORKA. *Proc. Phys. Soc., Lond., B*, **64**, 83–4 (*Jan.*, 1951).

Brief report of work in progress [Abstr. 3057 (1949)].

534.321.9 : 621.791.335

2477. Ultrasonic soldering irons. B. E. NOLTINGK AND E. A. NEPPIRAS. *J. Sci. Instrum.*, **28**, 50–2 (*Feb.*, 1951).

Two instruments which have been developed to facilitate the tinning of Al and other light metal surfaces are described. Intense ultrasonic vibrations from a magnetostriction transducer are used to produce cavitation in molten solder in contact with the metal surface. One instrument is designed to be used in the conventional manner and is suitable for soldering thin sheet; in the other, the vibrations are communicated to a solder bath in which small pieces of metal and also foil and wires can be tinned by dipping. A.

534.78

2478. Speech, language, and learning. N. WIENER. *J. Acoust. Soc. Amer.*, **22**, 696–7 (*Nov.*, 1950).

Deals with the amount of information which can be conveyed in a speech transmission system, and with the loss of information which occurs in operating a transmission system. The general discussion includes not only the "line" (wire or radio, for example), but also the transmitter (the human voice) and the receiver (the ear and brain) characteristics.

A. B. WOOD

534.78

2479. Language engineering. G. A. MILLER. *J. Acoust. Soc. Amer.*, **22**, 720–5 (*Nov.*, 1950).

Discusses the problems likely to arise in language engineering "if it existed"—such as auxiliary international language, spelling reform, special vocabularies, recoding procedures, translation, phonetic typewriter, etc. Refers also to psychological research on voice communication circuits and in the presence of an interfering masking noise. A. B. WOOD

534.78

2480. Communication patterns in task-oriented groups. A. BAVELAS. *J. Acoust. Soc. Amer.*, **22**, 725–30 (*Nov.*, 1950).

Discusses the various ways in which individuals in a task-group can be linked to one another, it being assumed that every individual in a group is linked to at least one other individual in the same group. The communication patterns considered resolve themselves into simple geometrical forms. Experiments to test the theory of the proposals are described.

A. B. WOOD

534.78

2481. On phonetic characteristics of speech. A. MOLES. *C.R. Acad. Sci., Paris*, **231**, 1126–8 (*Nov.* 20, 1950) *In French.*

Brief discussion of a method of analysing the quality of speech, as distinct from that of the voice, by observation of recorded sound. W. W. GEHR

534.78

2482. Information theory. W. JACKSON. *Nature, Lond.*, **167**, 20–2 (*Jan.* 6, 1951).

Report of a conference held in the Royal Society rooms during Sept. 26–29 (1950). Papers were read on: the evolution of information theory; statistical communication theory; the relation of communication theory to physics; quantal aspects of scientific information; statistical approach to the analysis of time series; the theory of radar information; fluctuations and theory of noise; linguistic theory; relevant aspects of hearing and vision theory; experimental psychology and neurophysiology; the operation of computers as coders of information and the construction of machines which can play games; criteria of prediction and discrimination; entropy, time and information; speech recognition using "visible speech," and electronic correlators.

534.78 : 518.5

2483. Correlation function analysis. L. G. KRAFT. *J. Acoust. Soc. Amer.*, **22**, 762–4 (*Nov.*, 1950).

The correlation function (c.f.) may be expressed in terms of the random time function in various ways, each of which has its applications. These are discussed, in particular the use of the Digital Electronic Correlator, which takes samples of the function (amplitude of input voltage), converts these to pulses representing amplitude in the binary number system, multiplies the pairs of samples, and adds the products of a great number of pairs to give the c.f. Some examples of correlation curves of speech are given. The instrument also has applications in the measurement of system responses. A. J. KENNEDY

534.78 : 518.5

2484. Autocorrelation analysis of speech sounds. K. N. STEVENS. *J. Acoust. Soc. Amer.*, **22**, 769–71 (*Nov.*, 1950).

The autocorrelation function (a.c.f.) of a time function $f_1(t)$ may be written as $\phi_{11}(\tau) = \overline{f_1(t) \cdot f_1(t-\tau)}$, where τ is a delay time. All information concerning the phases of the frequency components is lost, the averaging giving a representation of the average statistics of $f_1(t)$. The short-time a.c.f. may be obtained by integrating over a finite interval, but, proceeding continuously, this gives a running $\phi_{11}(\tau)$ varying with time. Measurement of this may be achieved by driving a l.s. unit coupled to an acoustic tube terminated to give no reflections. The outputs of 2 microphones in the side walls, one fixed, one movable along the tube (varying τ) are multiplied and integrated: this integral is recorded by an ink recorder. Typical speech sounds are illustrated. The method appears to be most promising for fricatives. A. J. KENNEDY

534.78 : 519.2

2485. Portrayal of some elementary statistics of speech sounds. S. H. CHANG. *J. Acoust. Soc. Amer.*, **22**, 768–9 (*Nov.*, 1950).

A short note on the choice of statistics and their significance, in particular those derived from the distributions of the intervals between (*a*) successive zero crossings, and (*b*) successive max. and min. The reciprocals of the harmonic means of the (*a*) and (*b*) distributions are particularly useful. For full analysis, a combination of methods may be necessary. A. J. KENNEDY

534.78 : 534.41

2486. Sonograph and sound machines. J. DREYFUS-GRAF. *J. Acoust. Soc. Amer.*, **22**, 731–9 (*Nov.*, 1950).

A description is given of a new class of electro-acoustical instruments. The "sonograph" consists of an electronic part which converts sounds into simplified groups of electric impulses, and a mechanical part which transforms these impulses into characteristic actions like graphic signals. When this mechanical part includes a drawing oscillograph or typing machine, reference is made to steno- or typo-sonograph respectively. A new sonographic alphabet has been developed and is described. Reproductions of letters and words recorded by the steno- and typo-sonographs are shown. A. B. WOOD

534.83 : 621.38

2487. Note on the definition of complex noise having a continuous spectrum [white noise]. P. CHAVASSE AND R. LEHMANN. *Ann. Télécommun.*, **5**, 375–7 (*Nov.*, 1950) *In French.*

Emphasizes the importance, in architectural acoustics, of distinguishing the two possible definitions, i.e. equal energy for equal arithmetic frequency intervals ΔF or for equal geometric intervals $\Delta F/F$, and shows how sound analysers of the heterodyne and constant band-ratio types give different results for the same noise. The constant $\Delta F/F$ basis is considered more rational, as corresponding with the characteristics of the ear. F. F. ROBERTS (R)

OPTICS . RADIATION . SPECTRA 535

535.215 : 537.312.5

The second order photoelectric effect of a metal surface. *See Abstr.* 2695

535.23.08

2488. Thermocouple bolometers. L. GEILING. *Ann. Télécommun.*, **5**, 417–26 (*Dec.*, 1950) *In French.*

Wire, sheet and "scale" types of radiation-detecting thermocouples are discussed and their properties analysed mathematically in terms of (*a*) sensitivity, (*b*) time constant, (*c*) the rapidity with which they respond to changes of incident radiation, (*d*) the resistance, and (*e*) the yield, which is a function relating the voltage developed to the resistance and the incident power. Various types of practical device are described. The recently developed "scale" thermocouple consists of a Cu cylinder with an insulating layer of Al oxide on which is wound a 0·5 cm dia. helix of Au, carrying a large number of small metal/metal thermocouples mounted like tiles on a roof. The resistance of the unit is of order $10^4\ \Omega$ and the time constant about 1 000 times less than that of a simple metal/metal device. C. A. HOGARTH

535.23.08 : 621.383 : 621.317.794

2489. Thermocouples and high-sensitivity photocell compensation for radiation measurement. W. LEO AND W. HÜBNER. *Z. angew. Phys.*, **2** (*No.* 11) 454–61 (1950) *In German.*

A balanced-photocell (two-in-series) circuit using automatic compensation employs one tetrode (as triode) and artificial damping, and has 7 ranges (1 to 100), the lowest being 0 to 2·5 μV. A recording instrument can be operated directly without further amplification. A system of 3 mirrors produces an optical lever of the ratio 6·4 : 1 and the mirror galvanometer directs the split-light beam on to the 2 photocells. This instrument records the spectrum from 0·5 to 1·8 μ within 10 min. The paper of the recorder advances 30 mm/min. The reference (zero) line can be moved to any position on (even off) the paper strip. An accuracy of $\pm$ 0·001 μW measured energy can be achieved. W. SUMMER

535.23.08 : 621.383 : 621.317.794

2490. A photocell compensator of high sensitivity for measurements with thermal radiation detectors. W. HÜBNER. *Elektrotechnik, Berlin*, **4**, 378–85 (*Nov.*, 1950) *In German.*

This photoelectric compensator has seven ranges

and measures as well as records d.c. voltages from 10^{-6} to 10^{-3} V. This arrangement is about 12× as sensitive as other types of photoelectric compensators. In spectrum analysis the time is reduced to between 10 to 20 min. The circuit and layout of the compensator is described and tables of characteristics are given. See also preceding Abstr. W. SUMMER (R)

535.231.4

2491. Spectral emissivity of coatings of thoria and other refractories as a function of temperature. F. H. MORGAN. *J. Appl. Phys.*, **22**, 108–9 (*Jan.*, 1951).

535.235 : 537.583

2492. The spectral emittance of nickel- and oxide-coated nickel cathodes. S. L. MARTIN AND G. F. WESTON. *Brit. J. Appl. Phys.*, **1**, 318–24 (*Dec.*, 1950).

The spectral emittance values at a wavelength $\lambda = 0{\cdot}66\,\mu$ have been measured for various types of oxide-coated cathode, and for Ni cores, using a cylindrical diffuse reflectometer. The influence of various factors, essentially affecting the surface condition, on the emittance has been examined. Tables show for Ni the effect of stoving treatment, temperature and getter flash; and for oxide-coated cathodes the strong effect of the oxide surface texture, and the subsidiary effects of glass tube baking temperature, and getter flash. A.

535.242

2493. A photometric separator for precision visual spectrophotometry. J. TERRIEN AND F. DESVIGNES. *J. Opt. Soc. Amer.*, **40**, 845–8 (*Dec.*, 1950).

The photometric separator here described, illuminated by monochromatic light, enables accurate visual measurements of the transmission factors of parallel plates to be made. The geometrical design has been developed to eliminate systematic errors. The scale of densities depends upon Talbot law. Within the uncertainties of visual settings, the results of measurements are in very good accordance with those obtained from the best available photoelectric methods. Improvements are possible with a larger monochromator. A.

535.242.6

2494. Three-line method of obtaining characteristic curves for heterochromous photometry. M. GREEN. *J. Opt. Soc. Amer.*, **40**, 842–4 (*Dec.*, 1950).

By employing 3 homologous spectrum lines, 2 in one wavelength range, and a 3rd in the 2nd wavelength range, it is possible to construct the 2 characteristic curves for heterochromous photometry. Spectra containing the 3 lines are recorded, at several levels of density, on the photographic emulsion to be calibrated. This provides data for a homochromous and a heterochromous preliminary curve. Calibration curves are constructed in the usual manner from these 2 preliminary curves. A.

535.244 : 621.327.43 : 628.972

2495. Method of testing and evaluating fluorescent luminaires. J. K. FRANCK. *Illum. Engng, N.Y.*, **45**, 763–70 (*Dec.*, 1950).

Accurate determination of the light distribution curves for fluorescent luminaires is difficult because the large mechanical dimensions of the source make it impossible to apply the inverse square law at distances practicable in most laboratories. The author overcomes the difficulty by dividing the luminaire into sections, each 2 ft in length, by means of non-reflecting diaphragms. Not only can the true distribution curves then be obtained by summation, but the illumination on a plane at any specified distance from the luminaire can be calculated directly.

J. W. T. WALSH (R)

535.247.4

2496. A galvanometer scale for the direct reading of intensities. J. C. DELANEY. Letter in *J. Opt. Soc. Amer.*, **40**, 787–8 (*Nov.*, 1950).

535.247.4

2497. A simple automatic recording microphotometer. R. M. FISHER AND D. S. MILLER. Note in *Rev. Sci. Instrum.*, **21**, 938–9 (*Nov.*, 1950).

535.247.4 : 537.542

2498. Ultraviolet photon counting with an electron multiplier. A. H. MORRISH, G. W. WILLIAMS AND E. K. DARBY. Note in *Rev. Sci. Instrum.*, **21**, 884–5 (*Oct.*, 1950).

Describes the use of photo-multiplier tubes with Be–Cu photo-cathode to measure weak u.v. radiation from luminescent alkali halides. Details of the calibration tests, using a hydrogen lamp as a source of u.v. light ($\lambda = 2\,000$–$2\,750$ Å), are given with data on the photo-multiplier tube sensitivity. Other applications of the technique are briefly mentioned.

J. D. CRAGGS

535.31

2499. Optical design by a matrix method. C. W. HARRIS. *J. Opt. Soc. Amer.*, **40**, 819–22 (*Dec.*, 1950).

A symmetrical optical system consists of a series of vertex-to-vertex intervals separating coaxial refracting or reflecting surfaces of revolution. This paper develops two types of matrices composed of constant elements, one representing intervals and the other surfaces. These matrices are multiplied together in the same order as the corresponding intervals and surfaces occur in the optical system. The resultant product matrix expresses the paraxial, aberrational and chromatic behaviour of the system. Such a formulation may be applied mechanically by unskilled computers, and suggests a passive electrical network analogue to optical systems. The surfaces are not limited to spheres. A.

535.31 : 535.41

2500. High precision measurements with simple equipment. A. C. S. VAN HEEL. *J. Opt. Soc. Amer.*, **40**, 809–16 (*Dec.*, 1950).

The precision of alignment attainable with a single slit, a double slit and cross wires, placed respectively at the 3 points to be aligned, can be about at least 0·17 in, provided use is made of pointings on transition colours in the interference pattern. Practical uses of this method are described, including technical measurements and laboratory experiments of very high precision. Among the last is a spherometer for large radii, that is also an absolute flatness tester with a precision of about $\lambda/100$. The method can be expanded to other types of measurement, when instead of a double slit a grating of coarse structure is substituted. Alignment in two directions simul-

taneously can also be achieved by a modification of the diffracting screen. A.

535.33 : 537.228.5

2501. On the time-variation of the intensity asymmetry of the hydrogen Stark effect. R. GEBAUER. *Z. Phys.*, **128** (*No.* 4) 494–9 (1950) *In German.*

Briefly describes expts. on the Stark effect observed with H canal-rays passing through suitable electric fields. Time lags of $\sim 10^{-9}$ sec were encountered in the establishment of the intensity patterns when the field changed from "parallel" to "anti-parallel." J. D. CRAGGS

535.33/.37 : 539.13 : 545.82

2502. Molecular spectra and molecular structure. I. Spectra of diatomic molecules (second edition). G. HERZBERG. *London: McMillan & Co.; New York: D. Van Nostrand Company* (1950) 658 *pp.*

A full and authoritative treatment both of the theory of the spectra of diatomic molecules and of the techniques of analysis, well-illustrated with figures and reproductions of spectra. The emphasis is primarily theoretical, and experimental procedures are not considered explicitly. The book also contains a bibliography of about 1 600 items and a comprehensive table of the rotational and vibrational constants for all the electronic states of known diatomic molecules, complete to September 1949. Much of the information given has involved critical analysis and re-calculation, and is not available elsewhere. R. F. BARROW

535.33.07–15

2503. A double-beam infra-red spectrometer with fast-scanning cathode-ray tube display. E. F. DALY. Letter in *Nature, Lond.*, **166**, 1072–3 (*Dec.* 23, 1950).

535.33.072

2504. A step-factor for the astigmatic spectrograph. R. E. THIERS. *J. Opt. Soc. Amer.*, **40**, 849–51 (*Dec.*, 1950).

A step-sector is described which can be used with astigmatic spectrographs to give results in every way as good as those obtained with conventional sectors and stigmatic instruments. In its action it may be described as a cross between a focal plane shutter and a band saw, as it consists of a continuous band of opaque film with a succession of stepped openings cut from its centre. This film is passed at high speed in front of the focal curve next to the sensitive emulsion, then around a return path which is not in the optical path of the instrument. Added versatility is achieved by the inclusion of adjustable vertical and horizontal masks. A.

535.33.072

2505. An apparatus for time-resolved spectroscopy. G. GORDON AND W. M. CADY. *J. Opt. Soc. Amer.*, **40**, 852–3 (*Dec.*, 1950).

An apparatus is described for making time-resolved spectrograms of single sparks or other short-time sources of light. Our adaptation of a conventional quartz spectrograph provides for sweeping the image of a selected region of the light source along the length of the slit by means of a rotating mirror. The time base can be made as short as 10 μsec and time resolution of events in the source as brief as 0·5 μsec. A.

535.33.072 : 535.338.3

2506. Studies on weak lines in optical spectra. P. JACQUINOT. *Proc. Phys. Soc., Lond., B*, **63**, 969–79 (*Dec.* 1, 1950) *In French.*

Solutions to the problem of the observation of weak spectral lines, using techniques based on self-absorption, or on the use of shaped diaphragms or screens, are described and illustrated by work on intercombination lines in He. R. F. BARROW

535.331

2507. Further remarks on Araki's theory of inverted alkali doublets. T.-Y. WU. *J. Phys. Soc. Japan*, **5**, 421–3 (*Nov.–Dec.*, 1950). See Abstr. 5682 (1950).

535.331 : 539.153

2508. On the deep configurations of V I and Cr II. A. A. SCHWEIZER. *Phys. Rev.*, **80**, 1080–2 (*Dec.* 15, 1950).

The theoretical formulae for d^3s^2, d^4s and d^5 are compared with the experimental data of V I and Cr II; the Cr II terms are assigned to configurations. The agreement remains practically unimproved by taking into account the interactions between configurations. See also Abstr. 283 (1947). A.

535.338.1

2509. First spectrum of arsenic. W. F. MEGGERS, A. G. SHENSTONE AND C. E. MOORE. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 346–56 (*Oct.*, 1950).

The spectrum emitted by neutral As atoms was observed photographically in the i.r., visible and u.v., and new lines were discovered in each spectral region. Measured wavelengths and estimated relative intensities are given for 330 lines, ranging from 1 407·34 to 11 679·9 Å in wavelength and from 1 to 2 000 in intensity. More than 74% of the total number and 97% of the total intensity of observed lines have been explained as combinations of 30 odd energy levels arising from $4s^2\,4p^3$ and $4s^2\,4p^2\,np$ electron configurations and 58 even levels from $4s\,4p^4$, $4s^2\,4p^2\,ns$, and $4s^2\,4p^2\,nd$. The average difference between observed and computed wave numbers is 0·14 cm^{-1}. Most of the observed levels have been assigned to doublet and quartet terms, and spectral series of the type $4s^2\,4p^3$–$4s^2\,4p^2\,ns$ have been identified. Calculations based on these series yield an absolute value of 79 165 cm^{-1} for the ground state $4s^2\,4p^3\,{}^4S^\circ_{3/2}$ of neutral As atoms, that is, an ionization potential of 9·81 ± 0·01 eV. A.

535.338.32

2510. The quenching of mercury resonance radiation. I. The effective cross sections of paraffin hydrocarbons. B. DEB. DARWENT. *J. Chem. Phys.*, **18**, 1532–7 (*Dec.*, 1950).

These have been measured by the technique of Zemansky. The effective cross-section of ethane is much smaller than the value previously found by Bates. Neopentane is reasonably efficient in quenching λ2537 although it is not decomposed readily by $Hg(^3P_1)$ atoms. Increase in molecular weight and, up to a point, in branching of the C skeleton are accompanied by increases in the effective cross-section. The quenching efficiency of the paraffins depends on the number and type of C–H bonds in the molecule and is not primarily a function of the number of C atoms or C–C bonds. The effective quenching

diameters of the C–H bonds are: primary 0·05 to 0·10 Å, secondary 0·50 to 0·65 Å, and tertiary 1·3 Å; the actual values depending to some extent on the nature of the rest of the molecule. The number of collisions necessary for quenching to occur on primary, secondary and tertiary C–H bonds is, therefore, approximately 3 000, 30 and 5, respectively. A.

535.338.332

2511. Revision of the hyperfine structure of the mercury spectrum. K. MURAKAWA AND S. SUWA. *J. Phys. Soc. Japan*, **5**, 429–34 (*Nov.–Dec.*, 1950).

The hyperfine structure of λ5790, λ5789·7, λ5769 and λ4047 of the spectrum of Hg I was studied, and the structure of some terms was determined. The ratio of the hyperfine structure constant of Hg^{199} to that of Hg^{201} was calculated for the terms $6p\ ^1P_1$, $6p\ ^3P_2$ and $7s\ ^3S_1$, and it was found that the ratio is anomalous for the term $6p\ ^1P_1$. The quadrupole moment of Hg^{201} was calculated to be $0{\cdot}3_5 \times 10^{-24}$ cm^2. Regularity in the displacement of even isotopes in lines of the Hg spectrum was found to exist in such a way that the ratio of the spacings Hg^{204}–Hg^{202} : Hg^{202}–Hg^{200} : Hg^{200}–Hg^{198} is constant for all lines examined and is equal to 1 : 0·933 : 0·880. The same qualitative regularity was found in the isotopic displacement in lines of heavy elements consisting of at least 3 even isotopes. A.

535.338.332

2512. Angular dependence of hyperfine structure for the copper ion. E. F. CARR AND C. KIKUCHI. Letter in *Phys. Rev.*, **80**, 1107 (*Dec.* 15, 1950).

535.338.333

2513. On the isotope shift in the Cu I resonance lines. P. BRIX AND W. HUMBACH. *Z. Phys.*, **128** (*No.* 4) 506–10 (1950) *In German.*

The hyperfine structure of the lines at 3 274 and 3 247 Å was examined by the absorption method, using a beam of Cu atoms and etalons of different spacings. The total separation for the Cu I ground state was + 390 for Cu 63 and + 418 for Cu 65, with an isotope shift of − 18 ± 4 (Cu 65 lower) relative to the $3d^{10}4p^2P_{\frac{1}{2}}$ term (all values $\times 10^{-3}$ cm^{-1}). A comparison with previous determinations for the ^2D states shows specific mass effects to occur in Cu I.

S. T. HENDERSON

535.338.333

2514. A spectroscopic determination of the shift of the 3*S* term in hydrogen. G. W. SERIES. Letter in *Nature, Lond.*, **166**, 961 (*Dec.* 2, 1950).

535.338.333

2515. Measurement of the mean life of the resonance level 6^3P_1 for different isotopes of mercury. R. LENNUIER AND J.-L. COJAN. *C.R. Acad. Sci., Paris*, **231**, 1450–2 (*Dec.* 18, 1950) *In French.*

By measurements on the polarization of Hg resonance radiation in a magnetic field, the value 0·11 μsec was determined for the even isotopes (200 and 202), 0·145 μsec for 199 and 0·225 μsec for 201. Previous work is considered.

S. T. HENDERSON

535.338.4

2516. Perturbations in the BaO spectrum. I. KOVACS AND A. LAGERQVIST. Letter in *J. Chem. Phys.*, **18**, 1683–4 (*Dec.*, 1950).

535.338.4

2517. Spectrum of the boron monosulfide (BS) molecule. P. B. ZEEMAN. Letter in *Phys. Rev.*, **80**, 902 (*Dec.* 1, 1950).

535.338.4

2518. On the emission spectra of ammonia and heavy ammonia excited by electron impact. H. CHAUVIN AND S. LEACH. *C.R. Acad. Sci., Paris*, **231**, 1482–4 (*Dec.* 18, 1950) *In French.*

The spectra were photographed in discharges at 0·1, 1 and 5 mm Hg pressure. The different band systems present are listed, including several new ones for ND. Constants for the ND vibration band at ~ 4 485 Å are calculated and the band identified as $^1\Pi$–$^1\Sigma(0, 0)$, which is at a higher frequency by 127 cm^{-1} than the corresponding band for NH.

S. T. HENDERSON

535.338.4

2519. The band spectrum of HgIn. R. L. PURBRICK. *Phys. Rev.*, **81**, 89–94 (*Jan.* 1, 1951).

An examination of the band spectrum of the HgIn molecule has been carried out using the 2nd order of the Wisconsin 21 ft reflection grating. Band systems were obtained with intensity maxima at 4 102, 4 511, 4 994, 5 226, 5 544 and 5 760 Å. The systems at 4 102 Å and 4 511 Å appear to be continuous, but the others have been resolved into bands. Vibrational analyses were made of the 4 994 Å, 5 226 Å and 5 544 Å systems; but the 5 760 Å bands have not yet been successfully worked into a single square array. A.

535.338.4 : 535.35

2520. Mechanisms of excitation of the $C^3\Pi_u$ state of molecular nitrogen. R. W. NICHOLLS. Letter in *Nature, Lond.*, **167**, 31–2 (*Jan.* 6, 1951).

Results are presented which support an indirect mechanism, $X^1\Sigma_g^+ \rightarrow$ intermediate singlet state "b" $\rightarrow C^3\Pi_u$, at least in the glow-discharge.

R. F. BARROW

535.338.4–31

2521. A new ultra-violet band-system of SiF. W. H. DOVELL AND R. F. BARROW. Letter in *Proc. Phys. Soc., Lond., A*, **64**, 98–9 (*Jan.*, 1951).

535.34 : 548.7

Colour centres in crystals. *See Abstr.* 3196

535.34 : 548.7

2522. *V*-centers in alkali halides. R. CASLER, P. PRINGSHEIM AND P. YUSTER. *J. Chem. Phys.*, **18**, 1564–71 (*Dec.*, 1950).

V-centres are defined as stabilized positive holes. The peak wavelengths of 3 *V*-bands of KCl, KBr, and NaCl are listed. Most of the paper deals with KCl, but the results are typical for KBr and NaCl as well. Experimental data are given concerning the conditions under which the various *V*-bands are obtained and their unequal stability with regard to bleaching by light and temperature. Crystals irradiated at various temperatures and observed at room temperature show superpositions of the V_2- and V_3-bands with relative intensities depending greatly on the temperature at which the crystals were irradiated and on the nature of the primary radiation. The V_1-band can be observed only at temperatures

below — 100°c. These data are compared with those published by other investigators, and possible mechanisms discussed. A.

535.343

2523. Polarization spectra of anthracene derivatives. N. D. Zhevandrov. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 25–8 (1950) *In Russian.*

535.343.2–14

2524. Remarks on the nuclear resonance shift in metallic lithium. W. Kohn and N. Bloembergen. Letter in *Phys. Rev.*, **80**, 913 (*Dec.* 1, 1950).

According to Townes *et al.* [see Abstr. 5958 (1950)] the frequency shift for an atom in the metallic state with respect to the same atom in a non-metallic compound is proportional to the spin contribution χ to the paramagnetic susceptibility of metallic Li and to $R = \psi_F^2/\psi_{2s}^2$, where ψ_F and ψ_{2s} are the wave functions at the nucleus of an electron on the Fermi surface of metallic Li and of the 2*s*-electron in the Li atom respectively. Experimentally $R = 0{\cdot}77$. The ion-core potential calculated by Seitz has been applied in the present paper to the evaluation of ψ_{2s}^2, giving the value $0{\cdot}22$ in agreement with the h.f.s. separation of the ground state of Li. The cellular method gives $0{\cdot}30$ for ψ_F^2, thus the theoretical value of R is $1{\cdot}4$, and the disagreement with experiment is serious. Either the experimental value of χ is unreliable, or the cellular method is unsuitable for a description of an electron on the Fermi surface. L. Pincherle

535.343.2–34

2525. Absorption spectra of samples of quartz and corundum in ultraviolet. Electric and thermic treatment of quartz. R. Bauple, A. Gilles, J. Romand and B. Vodar. Letter in *J. Opt. Soc. Amer.*, **40**, 788–9 (*Nov.*, 1950).

535.343.3–14

2526. Microwave spectroscopic evidence for internal rotation in methyl silane. D. R. Lide and D. K. Coles. Letter in *Phys. Rev.*, **80**, 911 (*Dec.* 1, 1950).

535.343.3–14

2527. The microwave spectrum and structure of methyl acetylene. R. Trambarulo and W. Gordy. *J. Chem. Phys.*, **18**, 1613–16 (*Dec.*, 1950).

From measurements of the $J = 1 \rightarrow 2$ rotational transitions of methyl acetylene and some of its isotopic modifications, the moments of inertia, I_B (in the units 10^{-40} g cm^2), were found for the ground vibrational state: for CH_3CCH, $98{\cdot}17_{23}$; for $CH_3C^{13}CH$, $98{\cdot}21_{32}$; for $C^{13}H_3CCH$, $100{\cdot}91_{93}$; for $CH_3CC^{13}H$, $101{\cdot}19_{92}$; for CH_3CCD, $107{\cdot}72_{34}$; and for CD_3CCD, $124{\cdot}58_{06}$. The centrifugal distortion constants, D_{JK}, in Mc/s are $0{\cdot}16_1$, $0{\cdot}1_6$, $0{\cdot}1_6$, $0{\cdot}1_3$, $0{\cdot}1_4$ and $0{\cdot}0_9$, respectively. The $J = 2 \rightarrow 3$ rotational transition of CH_3CCH was also measured, and the distortion constant D_J was found to be $0{\cdot}00_5$ Mc/s. Four lines of CH_3CCH corresponding to the $J = 1 \rightarrow 2$ transition and six lines for the $J = 2 \rightarrow 3$ transition in the excited vibrational state $v_{10} = 1$ and six lines for the $J = 2 \rightarrow 3$ transition in the excited state $v_9 = 1$ were measured and interpreted according to Nielsen's theory of *l*-type doubling in symmetric tops. The calculated structure for the ground vibrational state is: C — H (acetylenic), 1·056 Å; C ≡ C, 1·207 Å; C — C, 1·460 Å; C — H (methyl), 1·097 Å; ∠ HCH, 108° 14′. A.

535.343.3–15

2528. Infra-red spectra of unsaturated aromatic carbinols. A. R. Philpotts and W. Thain. Letter in *Nature, Lond.*, **166**, 1028 (*Dec.* 16, 1950).

535.343.3–15 : 535.375.5

2529. Infra-red and Raman spectra of para-difluorobenzene. A. H. Delsemme. Letter in *J. Chem. Phys.*, **18**, 1680 (*Dec.*, 1950).

535.343.32

2530. Absorption spectra of $Nd(NO_3)_3$ in various binary solvents. O. V. Fialkovskaya. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 469–72 (1950) *In Russian.*

535.343.32–14

2531. Interpretation of microwave spectra of diluted iron ammonium alum. P. H. E. Meijer. Letter in *Physica*, **16**, 812 (*Oct.*, 1950).

535.343.4–14

2532. Spectroscopy at centimetre wavelengths. B. Bleaney. *Research, Lond.*, **3**, 490–7 (*Nov.*, 1950).

A review of microwave gas spectroscopy for the non-specialist. D. H. Whiffen

535.343.4–14

2533. The structure of nitrosyl chloride from the microwave absorption spectrum. H. J. Bernstein. Letter in *J. Chem. Phys.*, **18**, 1514 (*Nov.*, 1950).

535.343.4–14

2534. Microwave magnetic resonance spectrum of oxygen. R. Beringer and J. G. Castle, Jr. *Phys. Rev.*, **81**, 82–8 (*Jan.* 1, 1951).

The complex magnetic-resonance spectrum of O gas is observed at 9 340 Mc/s in magnetic fields up to 9 000 oersted. Some 40 lines are resolved. A partial analysis of the spectrum is made with the help of Henry's recent Zeeman theory of O_2. Other lines are identified by the temperature dependence of the relative intensities. Line widths are measured by several techniques and range from 0·6 to 4 Mc/s/mm Hg at room temperature. The temperature and pressure dependence of the line widths are investigated. A.

535.343.4–14 : 535.338.334

2535. Collision broadening at microwave frequencies. D. C. M. Leslie. *Phil. Mag.*, **42**, 37–55 (*Jan.*, 1951).

A theoretical formula is deduced for the broadening and shift of spectral lines due to collisions; this formula is valid in the microwave region, for gases at low pressures. It is assumed that the partial collision amplitudes f for the bimolecular collision problem are known, and using these, the equation of motion of the two-molecule density matrix is found. A formula for the line broadening and shift follows from this. Using the equation of motion of the density matrix, it is also shown that a Boltzmann distribution is the only equilibrium one. A.

535.343.4–15

2536. The infra-red spectrum of nitrosyl fluoride. E. A. Jones and P. J. H. Woltz. Letter in *J. Chem. Phys.*, **18**, 1516 (*Nov.*, 1950).

535.343.4–15

2537. The infra-red absorption spectrum of isothiocyanic acid (HNCS). C. Reid. Letter in *J. Chem. Phys.*, **18**, 1512–13 (*Nov.*, 1950).

Assignment of fundamentals and partial resolution of fine structure. Suggested parameters: H–N 1·00, N=C 1·21, C=S 1·57 Å and ∠HNC 132° ± 3.

D. H. WHIFFEN

535.343.4–15

2538. Infra-red absorption of hydrogen induced by foreign gases. M. F. Crawford, H. L. Welsh, J. C. F. Macdonald and J. L. Locke. Letter in *Phys. Rev.*, **80**, 469–70 (*Nov.* 1, 1950).

Absorption induced in H_2 by He, A and N_2 is reported. The integrated absorption coeff. varies linearly with the product of foreign gas and H_2 densities. The half-width of 320 cm^{-1} at room temperature of rotational lines in induced absorption indicates a short period of perturbation and close collisions. This half-width is probably $\propto$ to the thermal velocity. J. JACOBS

535.343.4–15

2539. The infra-red spectra of propane and 2,2-dideuteropropane. H. L. McMurry and V. Thornton. Letter in *J. Chem. Phys.*, **18**, 1515–16 (*Nov.*, 1950).

535.343.4–15

2540. The infra-red spectra of $N^{15}N^{14}O^{16}$ and $N^{14}N^{15}O^{16}$. Some thermodynamic properties of the isotopic N_2O molecules. J. Bigeleisen and L. Friedman. *J. Chem. Phys.*, **18**, 1656–9 (*Dec.*, 1950).

The 3 fundamental frequencies of $N^{15}N^{14}O^{16}$ have been studied. One stretching frequency and the bending frequency in $N^{14}N^{15}O^{16}$ have similarly been investigated. The bending frequencies in $N^{15}N^{14}O^{16}$ and $N^{14}N^{15}O^{16}$ are found to be in good agreement with calculations from the product rule. Some slight changes are made in the force constants for the stretching vibrations in N_2O. The stretching frequency ω_3 in $N^{14}N^{15}O^{16}$ provides a good independent check on the force constants. The partition function ratios for isotopic exchange reactions involving N and O in N_2O are calculated. The isomerization equilibrium $N^{15}N^{14}O^{16}=N^{14}N^{15}O^{16}$ has been calculated over the temperature range 273·16°–1 000°K. A correlation is drawn between the structures of the isotopic isomers, $N^{15}N^{14}O^{16}$ and $N^{14}N^{15}O^{16}$, and the isomerization equilibrium. A.

535.343.4–15

2541. The vibrational spectra and structure of inorganic molecules. III. The infra-red spectra of nitrosyl chloride and nitrosyl bromide from 2·0 to 25 μ. W. G. Burns and H. J. Bernstein. *J. Chem. Phys.*, **18**, 1669–73 (*Dec.*, 1950).

See Abstr. 7123, 8619 (1950) for previous parts. The i.r. absorption spectra of NOCl and NOBr vapours have been examined from 400 to 5 303 cm^{-1}, and the spectra explained on the basis of three fundamentals at 1 799, 592 and 332 cm^{-1} for NOCl and 1 801, 542 and 265 cm^{-1} for NOBr. The force constants and the amplitudes for the fundamental modes were calculated for a central force system. The $P-R$ separation of the predominantly parallel bands and the spacing of rotational bands in one partially resolved mainly perpendicular band in the NOCl spectrum were found to be in good accord with the electron diffraction data for the dimensions of the molecule. Thermodynamic functions for the gases were calculated from 298° to 1 500°K. The calculated values of S^0_{298} for both gases are in good agreement with the experimental values. A.

535.343.4–15

2542. The multiplicity forbidden absorption bands in the spectrum of pyridine. C. Reid. *J. Chem. Phys.*, **18**, 1673–5 (*Dec.*, 1950).

The two singlet-triplet transitions of pyridine have been studied using very long optical paths. The first of these, a π-electron transition, which was previously observed in the liquid phase only as a region of continuous weak absorption at the long wave end of the main absorption system, has been observed in the gas phase as a well-defined band system between 3 000 and 3 300 Å with a maximum molar absorption coefficient, $\varepsilon = 0{\cdot}10$. The 60 observed bands have been fitted into a vibrational scheme which suggests that the transition responsible for them is allowed by symmetry. The second transition which involves the non-bonding pair of electrons on the N atom was observed previously as a low-temperature phosphorescence emission. Attempts to observe this transition in absorption using very long paths in the gas phase were unsuccessful, but it has been observed weakly using an optical path of 45 cm of liquid pyridine. A.

535.343.4–15

2543. The infra-red spectrum of C_2H_2 from 4 400 to 8 500 cm^{-1}. R. M. Talley and A. H. Nielsen. Letter in *J. Chem. Phys.*, **18**, 1680–1 (*Dec.*, 1950).

535.343.4–15 : 535.375.5

2544. Infra-red and Raman spectra of fluorinated ethanes. II. 1,1,1-trifluoroethane. J. R. Nielsen, H. H. Claassen and D. C. Smith. *J. Chem. Phys.*, **18**, 1471–6 (*Nov.*, 1950).

See Abstr. 5707 (1950) for part I. The i.r. absorption spectrum of gaseous 1,1,1-trifluoroethane between 2 and 23 μ has been investigated with a prism spectrometer of high resolution. The Raman spectrum of CF_3–CH_3 in the gaseous state has been photographed with a three-prism glass spectrograph of linear dispersion 15 A/mm at 4 358 Å. The 12 fundamental frequencies have been assigned, and the spectra have been interpreted in detail. Thermodynamic functions have been calculated. A value of 3 920 cal/mole has been obtained for the potential barrier opposing internal rotation. A.

535.343.4–15 : 535.375.56

2545. The infra-red and Raman spectra of cyclopentane, cyclopentane-d_1, and cyclopentane-d_{10}. F. A. Miller and R. G. Inskeep. *J. Chem. Phys.*, **18**, 1519–31 (*Dec.*, 1950).

The spectra have been determined for the purpose of establishing the symmetry of cyclopentane. D_{5h} selection rules are found to hold very well. This does not constitute a rigorous criterion for structure in this case, however, because drastic alteration of the symmetry by substituting groups such as D, OH, CH_3 or Cl for a hydrogen atom does not appreciably

increase the complexity of the spectra. The data have provided two strong arguments against a D_{5h} structure. The actual geometry of the molecule is still not known. It is shown that a rigid structure of symmetry C_s, C_2 or C_1 is consistent with the available data. Analogous spectroscopic results for perfluorocyclopentane are mentioned briefly for comparison. This molecule is definitely non-planar. The method of preparation of the D compounds is given. A Pd-on-charcoal catalyst is described which promises to be useful in other H–D exchange reactions. A.

535.343.4–15 : 539.133

2546. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. IV. The spectrum of methyl fluoroform (CH_3CF_3) from 19 μ to 0·7 μ. R. D. Cowan, G. Herzberg and S. P. Sinha. *J. Chem. Phys.*, **18**, 1538–44 (*Dec.*, 1950).

See Abstr. 1203 (1948), 1659, 4850 (1950) for previous parts. The absorption spectrum of methyl fluoroform has been investigated with path lengths up to 30 m in the region 19 to 0·7 μ. Three of the fundamentals have been assigned differently from Thompson and Temple. Since the molecule is nearly a spherical top, the ⊥ bands show the same typical *PQR* structure as do the || bands except when the Coriolis interaction constant ζ is large. This seems to be the case for the degenerate C–F stretching vibration $\nu_9(e)$ and for most binary combinations involving it. The CH_3 rocking vibration $\nu_{10}(e)$ is split into 2 close components (separation 6 cm^{-1}), a splitting that is here ascribed to the presence of three potential minima separated by low potential maxima. A large number of i.r. bands can be readily interpreted as binary combinations. The relative intensities of fundamentals and of overtone and combination bands are briefly discussed. A.

535.343.4–15 : 539.133

2547. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. V. The spectrum of isocyanic acid. C. Reid. *J. Chem. Phys.*, **18**, 1544–50 (*Dec.*, 1950).

The spectrum of isocyanic acid has been examined in the photographic i.r. using a 21 ft grating spectrograph and path lengths up to 500 m. The rotational structure of several bands has been analysed and the energy levels and moments of inertia determined. With their help the coarse rotational structure of 2 of the fundamentals has also been analysed. The molecular parameters fitting best our data and published electron diffraction results for the C–N and C–O bond distances are: $r(H\text{–}N) = 1{\cdot}00_0$ Å, $\measuredangle$ H–N–C = 125·5°. A.

535.343.4–15 : 539.133

2548. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. VI. The spectrum of nitrous oxide (N_2O) below 1·2 μ. G. Herzberg and L. Herzberg. *J. Chem. Phys.*, **18**, 155–161 (*Dec.*, 1950).

The photographic i.r. spectrum of N_2O has been investigated with absorbing paths up to 4 500 m atmos. 34 absorption bands have been found of which 23 have been measured and analysed in detail. improved vibrational constants ω_i^0 and x_{ik} have been determined which give a fair representation of all the bands. The remaining deviations which are outside the present limits of error are due to the effect of Fermi resonance between ν_1 and $2\nu_2$. Precise values of the rotational constants $B\nu_1\nu_2\nu_3$ have been determined for almost all vibrational levels involved in the observed bands. From the $B\nu_1\nu_2\nu_3$ values rotational constants α_i have been obtained, allowing the determination of the rotational constant in the equilibrium position, from which the moment of inertia in the equilibrium position has been found. The deviations of the individual $B\nu_1\nu_2\nu_3$ values from those obtained from the formula $B\nu_1\nu_2\nu_3 = B_e - \alpha_1(\nu_1 + \frac{1}{2}) - \alpha_2(\nu_2 + 1) - \alpha_3(\nu_3 + \frac{1}{2})$ are appreciably larger than would correspond to the errors of measurements and must be ascribed to the effect of the Fermi resonance. A.

535.345.6

2549. A new cement for gelatine light filters. J. W. Nicholas and F. F. Pollak. *J. Sci. Instrum.*, **28**, 23–4 (*Jan.*, 1951).

The synthetic resin Piccolyte WW 100 dissolved in xylene is proposed as a cement for gelatine light filters. Its advantages are a high thermal softening point, good adhesion to glass, absence of tendency to form air-bubbles, rapid drying and freedom from yellowing with age or on exposure to light. The technique of its use is described. A.

535.345.6 : 535.65

2550. An illuminant-converting filter for use with the automatic tristimulus integrator. H. R. Davidson, I. H. Godlove, J. M. Lambert and G. J. Wright. *J. Opt. Soc. Amer.*, **40**, 817–18 (*Dec.*, 1950).

If a suitable filter is placed in the sample beam of the recording spectrophotometer, the automatic tristimulus integrator may be used for calculations based on illuminants other than Illuminant C without a change in the cams. Instructions for making a filter for use in calculating tristimulus values based on an illuminant approximating Illuminant A are given. A.

535.35 : 535.338.4 : 537.525.8

2551. A note on the critical pressure effect in collisions of the second kind in molecular spectra. N. T. Tawde and G. K. Mehta. Letter in *Curr. Sci.*, **19**, 340–1 (*Nov.*, 1950).

Excitation of the Swan bands of C_2 is enhanced by A at an optimum pressure of about 15 mm. This optimum is interpreted as arising from the condition that the time between successive inelastic collisions is equal to the life-time of excited C_2. See also Tawde and Desai, *Proc. Indian Acad. Sci.*, **6**, 266 (1937). R. F. BARROW

535.371

2552. Measurements of the duration of fluorescence by means of a "phase fluorometer." M. D. Galanin. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 5) 925–7 (1950) *In Russian.*

Describes a fluorometer designed for the purpose of a less indirect measurement of $\phi[= \tan^{-1}(\omega\tau)]$ than that involved in previous fluorometers. The new feature of the instrument consists in a resonance, two-channel amplifier, tuned to the modulation frequency ($\simeq$ 24 Mc/s), with a heterodyne, common

for both channels. The accuracy of measurement for a sufficiently luminous fluorescence is $\pm$ (2 to 3) $\times 10^{-10}$ sec. Results are given of the duration measurements for 13 solutions and crystals.

F. LACHMAN

535.371

2553. Remarks on the depolarization of photoluminescence during its decay. S. I. VAVILOV. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1145–8 (1950) *In Russian.*

An exact depolarization formula for a practically momentary excitation is deduced. The formula is suitable for the interpretation of the phosphoroscopic measurements of Sevchenko with U glasses [*Dokl. Akad. Nauk, SSSR*, **42**, 349 (1944); *J. Exp. Theor. Phys., USSR*, **17**, 1063 (1947); Abstr. 5355 (1949)].

F. LACHMAN

535.371

2554. On the interaction of the activators in phosphors. Z. A. TRAPEZNIKOVA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 465–8 (1950) *In Russian.*

535.371

2555. The interpretation of the dependence of luminescent efficiency on activator concentration. P. D. JOHNSON AND F. E. WILLIAMS. *J. Chem. Phys.*, **18**, 1477–83 (*Nov.*, 1950).

The previously published analysis [Abstr. 5959 (1950)] of the dependence of efficiency of substitutionally activated inorganic phosphors on activator concentration is generalized to include a wide variety of inorganic phosphors under various types of excitation. In addition to the optical excitation of the activator, the creation of conduction electrons and excitons, and the transfer of their energy to the luminescent and non-luminescent activator ions and to other impurities and lattice defects are included in the formulation. The dependence of efficiency on activator concentration of ZnF_2 : Mn under c.r., X-ray, vacuum u.v. and near u.v. has been measured and interpreted on the basis of the theory. Preliminary photo-conductivity measurements clarify the role of the conduction band in the luminescence of ZnF_2 : Mn. Also the dependence of the efficiency *v.* activator concentration of both ZnF_2 : Mn and KCl : Tl on temperature has been measured and interpreted on the basis of the variation in activation energy for competing radiationless processes with distance between activator ions. In addition, other efficiency *v.* activator concentration data previously published by other authors on a variety of phosphors and at various temperatures can be correlated and explained with the general theory. A.

535.371

2556. Effect of infra-red on emission and trapping in ZnS : Cu phosphors. R. H. BUBE. Letter in *Phys. Rev.*, **80**, 764–5 (*Nov.* 15, 1950).

535.371

2557. The decays of luminescent KBr and LiF. A. H. MORRISH AND A. J. DEKKER. *Phys. Rev.*, **80**, 1030–4 (*Dec.* 15, 1950).

A photomultiplier, together with electronic pulse techniques, has been used to investigate the luminescent decay of KBr and LiF after irradiation with X-rays, at various temperatures. Decay curves plotted on a log-log scale are linear for KBr at 21°C and for LiF at 21°C and 0°C, with an average slope of 1·2. The curves for KBr at 0°C and the temperature of dry ice and acetone have linear upper and lower parts, connected by an intermediate curved part. It is suggested that the upper linear part is due to the decay of F' centres, and the lower part to the decay of F centres. The emission spectrum of KBr consists of 2 bands, a strong one centred at 4 550 Å and a weaker one at 5 300 Å, while that of LiF extends into the u.v. below 3 000 Å. A.

535.372

2558. Comparison of the luminescent spectra of crystals and solutions uranyl-sulphate. B. E. GORDON. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 5) 913–16 (1950) *In Russian.*

535.372

2559. Some optical properties of lead-activated sodium chloride phosphors. J. H. SCHULMAN, R. J. GINTHER AND C. C. KLICK. *J. Opt. Soc. Amer.*, **40**, 854–62 (*Dec.*, 1950).

Absorption and luminescence phenomena in NaCl : Pb phosphors have been found to be rather complex. Melt-grown NaCl : Pb has an asymmetrical, 2 730 Å peaked absorption band. The variation of emission spectrum with wavelength of excitation within this band shows that it consists of 2 poorly resolved absorption bands, one peaking at 2 730 Å and the other at 2 900 Å. At low Pb concentrations, irradiation into the first of these causes a near-u.v. emission peaking at 3 200 Å; irradiation into the second causes a visible emission peaking at about 4 500 Å. At high Pb concentrations, irradiation into the first band gives a second near-u.v. emission band peaking at 3 850 Å in addition to the one peaking at 3 200 Å. Precipitated NaCl : Pb shows all the above phenomena, and in addition, has an excitation band peaking at 2 600 Å, producing simultaneously a 3 300 Å peaked emission and a visible emission. The NaCl : Pb phosphors are unstable, deteriorating after a few days at room temperature and more rapidly at 130°. X-irradiation of these phosphors destroys the above absorption and emissions, and gives a print-out effect due apparently to the formation of colloidal Pb. The X-rayed material can be excited by near u.v. to give a red emission, peaking at about 6 100 Å. Some suggestions concerning the interpretation of the above phenomena are given. A.

535.375.54

2560. Raman spectrum of rutile (TiO_2). P. S. NARAYANAN. *Proc. Indian Acad. Sci. A*, **32**, 279–83 (*Oct.*, 1950).

This has been recorded using the visible radiations of the Hg arc. The 8 observed Raman lines have been partially explained on the basis of an elementary group-theoretical analysis. A.

535.375.54

2561. Vibration spectrum of hydrogen bonds. E. F. GROSS AND V. I. VALKOV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 453–6 (1950) *In Russian.*

Frequencies around 200 cm^{-1} found in combination scattering spectra of some crystals have previously

been attributed to H-bond vibrations. This view is confirmed by new results on ice crystals; after 100 hr exposure a spectrogram was obtained. New frequencies are observed in the region 300–160 cm^{-1}, the strongest one at 212 cm^{-1}. J. JACOBS

535.375.54

2562. The intensity of the external Raman and infrared lines of crystals. A. LOINGER. *Nuovo. Cim.*, **7**, 939–42 (*Nov.*, 1950) *In Italian.*

In several crystals built up by complex ions, the multiplicity of the external Raman and i.r. lines must be attributed to couplings of angular and translatory vibrations. Relations are given between the Raman intensities, the i.r. absorption coefficients respectively, and the interionic forces. In the simplest cases the problem can be treated as the problem of 2 coupled linear oscillators; the Raman or i.r. activity depends upon the motion of one of them. The introduction of normal co-ordinates reduces the case to that of 2 independent oscillators. In this way formulae for the Raman intensities and the i.r. absorption coefficients are easily obtained. A.

535.375.54

2563. The structure of para-di-chloro-benzene. B. D. SAKSENA. *J. Chem. Phys.*, **18**, 1653–6 (*Dec.*, 1940).

Two low-frequency spectra of the crystal of para-dichlorobenzene are reproduced, one of a single crystal very slowly cooled from melt, and the other of a crystal rapidly cooled. The 3 frequencies in the spectra of the single crystal have been shown to be rotational oscillations, the smallest frequency, 27 cm^{-1}, representing an oscillation about the axis of greatest moment of inertia which is the axis perpendicular to the plane of the molecule. From the X-ray data it is noticed that the molecules in the crystals of para-dichlorobenzene and para-dibromobenzene are differently orientated, but they can be brought into juxtaposition by a rotation about this axis. The different orientations of the molecules in these crystals are, however, incompatible with the fact that these crystals are isomorphous and form mixed crystals. It has therefore been postulated that the crystal of para-dichlorobenzene has a tendency to become disordered by the excitation of free rotation about the axis perpendicular to the plane of the molecule which results in the vanishing of the frequency 27 as noticed in the 2nd spectrum. A.

535.375.54 : 535.892

2564. Use of illuminators in the investigation of low-frequency Raman spectra of organic crystals. A. V. KORSHUNOV AND V. A. SELKIN. *J. Tech. Phys., USSR*, **20**, 745–9 (*June*, 1950) *In Russian.*

Describes an illuminating device with elliptical mirrors designed for the purpose of using great light intensities in order to reduce the exposure. This is of great importance when working at low temperatures or with substances that are decomposed by heat. The Raman spectrogram of a crystal of orthodiiodobenzene, obtained after a 1 hr exposure by using the new method compares favourably with that obtained after a 40 hr exposure using the ordinary low-power illumination. F. LACHMAN

535.375.54 : 548.7

2565. The scattering spectra and lattice symmetry of certain crystals with space group C_{2h}^5. A. V. KORSHUNOV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 691–4 (1950) *In Russian.*

The scattering spectra of the isomorphous crystals *p*-dichlorobenzene, *p*-bromchlorobenzene and *p*-dibromobenzene and in particular the mixed translation-orientation lines were carefully investigated. The space group is C_{2h}^5 and there are 2 molecules per cell. Single crystals $6 \times 1 \times 1$ cm were irradiated with both polarized and unpolarized light and the spectra in various directions were examined. 9 mixed lines corresponding very closely in intensity and position were found for each material and these 9 lines were also found in naphthalene, which has the same space group, although the correspondence was here not so close. A. L. MACKAY

535.375.55

2566. Influence of solvent on Raman spectra of tetrahedral molecules. J. FEDOSOW. *Comment. Phys. Math., Helsingf.*, **14** (*No.* 1) 40 *pp.* (1950) *In German.*

The effect is studied of solution in tin chloride, methyl alcohol, ethyl alcohol, acetone, ether, chloral, acetic acid, methyl acetate, ethyl acetate, acetyl chloride, benzene, monochlorbenzene and dioxane on the frequencies and intensities of Raman lines of CCl_4, $SiCl_4$ and $CHCl_3$. The 3 020 cm^{-1} line of chloroform was reduced by 7 cm^{-1} when dissolved in benzene or in dioxane, but in all other solvents was practically unaffected. This is a C–H vibration. The tangential vibrations 218 cm^{-1} of CCl_4, 151 cm^{-1} of $SiCl_4$ and 262 cm^{-1} of $CHCl_3$ vary in intensity by $+ 22\frac{1}{2}\%$ to $- 18\%$ in the different solvents. There is no simple relationship between the intensity variations and either the dielectric constant or the dipole moments. The other vibrations are practically unaffected. The influence of the solvents CCl_4, $CHCl_3$, methyl alcohol, methyl and ethyl acetates, and dioxane on the frequencies and relative intensities of the Raman lines of chlorbenzene were also studied. The frequencies were unaffected. The first three solvents produced considerable lowering in intensity of the lines 416, 296 and 194 cm^{-1}; dioxane increased the strength of 1 023 cm^{-1}; methyl acetate weakened 194 cm^{-1} and strengthened 416 cm^{-1}, while ethyl acetate weakened the latter line.

A. C. MENZIES

535.375.55

2567. Raman effect—apparatus for working with tiny amounts of liquids. M. VACHER AND Y. LORTIE. *C.R. Acad. Sci., Paris*, **231**, 1140–2 (*Nov.* 20, 1950) *In French.*

The tube for tiny samples is like a piece of thermometer tubing, having a bore of which the dia. is a few tenths of a mm. Plane windows are ground and polished on the outside of the tube, parallel to the bore, for the incident and scattered light respectively. Two methods are described: (*a*) right-angled scattering, (*b*) "direct" observation, using an ultramicroscope arrangement. (*a*) Two microscope objectives project light on the liquid column and focus the scattered light on the spectrograph slit respectively. The tube forms part of a micropipette, and the working volume of liquid is 0·03 mm. With a spectrograph employing two 60° prisms and an *f*/4·5

camera, Raman spectra are obtained in 10 hr with, e.g., acetate of vitamin A in chloroform. (*b*) The light is projected on to an ultramicroscope illuminator and from this converges on to the liquid in a flat cell. The scattered light is gathered by an oil-immersion objective. Comparing the two methods, (*a*) is preferred, since it is in practice more promising for reducing the mass of the sample. The advantage of such methods is pointed out for rare or for strongly absorbing materials, or for small crystals.

A. C. MENZIES

535.375.55

2568. Raman spectra of hydrocarbons. V. *n*-hexane, *n*-heptane, 2-methylpentane, 3-methylpentane, 2,4-dimethylpentane, and 2,3-dimethylbutane. F. F. CLEVELAND AND P. PORCELLI. *J. Chem. Phys.*, **18**, 1459–61 (*Nov.*, 1950).

Raman displacements, semiquantitative relative intensities and quantitative depolarization factors are given for the above-named hydrocarbons in the liquid state. The relative intensities and depolarization factors were obtained by use of a Gaertner microdensitometer. The depolarization factors were determined by a well-tested, single-exposure method. The previous data have been collected, tabulated and compared with the present results, and probable values and average deviations are listed. A.

535.375.55

2569. Raman spectrum of CD_3–CD_2H. R. VAN RIET AND M. DE HEMPTINNE. *Ann. Soc. Sci. Brux.*, **64**, *Ser.* 1, 177–87 (*Dec.*, 1950) *In French.*

Frequencies and depolarizations are measured and are allocated to the fundamental modes of vibration. The results are summarized in a table with previous results for similar molecules C_2H_6, C_2H_5D and C_2D_6.

A. C. MENZIES

535.375.55

2570. Refractive index correction in relative Raman intensity measurements. L. A. WOODWARD AND J. H. B. GEORGE. Letter in *Nature, Lond.*, **167**, 193–4 (*Feb.* 3, 1951).

Attention is drawn to the apparent failure in quantitative analysis using Raman spectral intensities to take account of change of refractive index when the scattering liquid is changed. This correction arises when the assumption is made that the Raman intensity is proportional to the volume concentration. If the refractive indices of the mixture and of the pure components are n and n_0 respectively, then the correction factor is $(n/n_0)^2$. A. C. MENZIES

535.376

2571. Scintillation decay times. A. LUNDBY. Letter in *Phys. Rev.*, **80**, 477 (*Nov.* 1, 1950).

By using a coincidence system with coaxial cables as delay lines the decay curves of terphenyl, diphenylbutadiene, stilbene, anthracene and naphthalene are accurately determined and the decay constants deduced. G. F. J. GARLICK

535.376 : 537.591.8

2572. Scintillations produced by cosmic rays. C. G. MONTGOMERY AND D. D. MONTGOMERY. Letter in *Phys. Rev.*, **80**, 757 (*Nov.* 15, 1950).

535.376 : 539.164

2573. Alpha-particle scintillations in organic compounds. B. COLLINGE AND E. J. ROBBINS. Letter in *Nature, Lond.*, **166**, 1109 (*Dec.* 30, 1950).

535.39

2574. Low reflectance coatings and the sensitivity curve of the eye. J. H. VAN DER MERWE AND H. VERLEGER. *Proc. Phys. Soc., Lond., B*, **64**, 76–81 (*Jan.*, 1951).

Heterochromatic light is treated and the spectral sensitivity of the human eye is taken into account. The conclusion is drawn that the optical properties required for low reflectance coatings can be obtained by treating the incident light as monochromatic. A.

535.39 : 538.566.2

2575. Investigations on the propagation of sinusoidal electromagnetic waves in stratified media. Application to thin films. II. Thin films. F. ABELÈS. *Ann. Phys., Paris*, **5**, 706–84 (*Nov.–Dec.*, 1950) *In French.*

See Abstr. 1199 (1951) for first part. Theoretical calculations are made for the optical properties of single thin films and then for several films superposed. An examination in detail is made for films on a transparent base used at oblique incidence. Questions of Brewster angle and total reflection are investigated. New expressions are given for total reflection for an absorbing film on glass. The phase change on transmission through an absorbing film is discussed, and the calculation carried through for Al, which is used for phase plates. Three new methods are proposed for the evaluation of the thickness and the refractive index of thin films. By these, refractive indices are determined for fluorides of Mg, Cu, Li and Al, cryolite, SiO_2 and TiO_2. A method is developed for deriving optical constants of metals which are coated by a thin transparent film. It is shown experimentally how the reflectivity of Al can be increased. The theory of systems of alternating thin films is developed.

S. TOLANSKY

535.41 : 535.323

2576. Interference with thin films in the infra-red. Determination of the refractive index of fluorite from 7 to 15 μ. RAMADIER-DELBÈS. *J. Phys. Radium*, **11**, 622–6 (*Nov.*, 1950) *In French.*

The method described uses the channel interference spectrum produced by placing a thin film before a spectrograph. The thickness is obtained from fringes in the visible region. Phase change effects are discussed. The spectra are registered by a thermo-pile. The values found earlier for the refractive index by Paschen using a prism in the region 8–9 μ fall closely on the curve given here. Comparison is made with the spectra of NaF and LiF. Curves are given for reflecting power as a function of wavelength in the region of the residual-ray metallic-reflection zone. S. TOLANSKY

535.417

2577. Fresnel interference in the Michelson interferometer. P. G. GUEST AND J. G. CLOUSTON. Letter in *J. Opt. Soc. Amer.*, **40**, 787 (*Nov.*, 1950).

535.417

2578. Optimum source size for the Mach–Zehnder interferometer. F. D. BENNETT. *J. Appl. Phys.*, **22**, 184–90 (*Feb.*, 1951).

A vector analytic treatment is given of the forma-

tion of undisturbed fringes by an ideal Mach–Zehnder interferometer with an extended source. The path difference of two interfering rays at an arbitrary point in the field is found to depend, in a simple way, upon the source point from which the rays originate, the field point examined, and a dyadic which is a function of the unit normals to the last mirror and divider plate of the interferometer. The fringe clarity condition, that all pairs of interfering rays reaching the field point have path differences within a specified range, is developed in the form of an inequality. Analysis of this fundamental inequality shows that all admissible area sources must be areas enclosed between two conics in the source plane. For fringes perpendicular to the plane of centres of the interferometer elements, the optimum source is a circle with radius inversely proportional to the square root of the number of clear fringes desired. This result holds for all interferometers of parallelogram planform. For fringes parallel to the plane of centres, each interferometer orientation presents a special case. The optimum source area is obtained for two of these, viz., the 45° and 30° interferometers. A.

535.417

2579. An improved beam divider for Fizeau interferometers. H. Barrell and J. S. Preston. *Proc. Phys. Soc., Lond., B*, **64**, 97–104 (*Feb.*, 1951).

A transparent material, presumed to be TiO_2, is suggested for replacing Al or Ag as a coating for glass beam dividers in Fizeau interferometers, particularly those adapted for measuring length or displacement in the reflected fringe system. The method of depositing the films, and their optical properties, are described; the coatings are very resistant chemically and mechanically. Evidence produced in photographs and microphotometer records, supplemented by calculations of fringe intensity distributions, shows that the performance of the new material in the interferometer is superior to that of Al and plain glass. A.

535.417 : 539.23

2580. The phase-shift measurement of thin films and its amplification. Letter in *J. Opt. Soc. Amer.*, **40**, 789–90 (*Nov.*, 1950).

535.42

2581. A method for the exact solution of a class of two-dimensional diffraction problems. P. C. Clemmow. *Proc. Roy. Soc. A*, **205**, 286–308 (*Feb.* 7, 1951).

A method is given, based on a representation of the scattered field as an angular spectrum of plane waves, which leads directly to a pair of "dual" integral equations. The unknown function in each of these dual integral equations is that defining the angular spectrum, and when this function is known the scattered field is presented in the form of a definite integral. The method is appropriate to two-dimensional problems in which a plane wave (of arbitrary polarization) is incident on plane, perfectly conducting structures, and for certain configurations the dual integral equations can be solved by the application of Cauchy's residue theorem. The three problems considered are those for which the diffracting plates, situated in free space, are, respectively, a half-plane, two parallel half-planes and an infinite set of parallel half-planes; the second of these is illustrated by a numerical example. The question of the nature of the singularity at a sharp edge is discussed, and it is shown that the solution for an arbitrary (three-dimensional) incident field can be derived from the corresponding solution for a two-dimensional incident plane wave. A.

535.42

2582. Fresnel diffraction at a transparent lamina. R. C. Faust. *Proc. Phys. Soc., Lond., B*, **64**, 105–13 (*Feb.*, 1951).

Fresnel diffraction at the edge of a transparent lamina has been studied and an analogy drawn between the observed phenomena and interference fringes of the Fizeau and Edser–Butler types. The variation of the diffraction pattern with changing wavelength has been employed to determine accurately both the thickness and the refractive index of thin transparent sheets. The refractive index was found by an immersion method, the accuracy of which is here discussed. The Becke line which is often observed during such measurements is shown to be a strongly asymmetrical diffraction pattern occurring when the thickness of a lamina changes over a small but finite distance. A.

535.43

2583. Brillouin components in light scattered by quartz. S. C. Sirkar and G. S. Kastha. Letter in *Nature, Lond.*, **166**, 1073–4 (*Dec.* 23, 1950).

535.434

2584. Variation of the coefficient of the absorption of light as dependent upon the variation of the diameters of particles suspended in water. K. I. Ivanov. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 5) 925–8 (1950) *In Russian.*

According to this article V. V. Shuleikin and A. V. Trofimov first theoretically proved the connection between dispersion of light and the high absorbent capacity of particles suspended in sea-water. Practical experiments have now been carried out by the present author in order to illustrate this connection, using kaolin and clay silt. His data show that the dependence can be expressed by the equation $K = aB$, where B represents a substance composed of particles of equal diameter and a the constant of dependence. a attained its maximum, in the red part of the spectrum, with particles of $1{\cdot}5\,\mu$ dia. (approximately equal to 2λ). Further increases of diameter led to a diminution in the value of a. The conclusion is drawn that absorption of light is proportional to wavelength (measurable at any depth by a Pulfrich-type photometer) and varies inversely in its proportion, e.g. from λ^2 to λ^0 with particle diameters of $500\ \mathrm{M}\mu < D < 3\,\mu$. J. CLEUGH

535.435 : 541.123

2585. The theory of critical points. L. Tisza. *J. Phys. Coll. Chem.*, **54**, 1317–23 (*Dec.*, 1950).

A survey of older theories of critical fluctuations is followed by details of the cellular method of calculation. An equation is stated for the critical light scattering for fluid systems which reduces to the result of Ornstein and Zernicke (1914) or to that of Rocard [*J. Phys.*, **7**, 165 (*April*, 1933)] with appropriate special assumptions. C. TURNER

535.435 : 541.123.2

2586. Opalescence of a two-component liquid system near the critical mixing point. B. H. ZIMM. *J. Phys. Coll. Chem.*, **54**, 1306–17 (*Dec.*, 1950).

The system observed is CCl_4 and C_7F_{14} and the light-scattering is measured with the apparatus described in an earlier publication [Abstr. 2457 (1949)] the formula of Einstein is used in which the quantity $d \ln a_1/d \ln \phi_1$ equals $1 - \sum_1^\infty B_n \phi_2^n$ for systems not obeying Raoult's law. The second-order transition predicted by Mayer [*J. Chem. Phys.*, **5**, 67–73 (*Jan.*, 1937)], M'Millan and Mayer [*J. Chem. Phys.*, **13**, 276–305 (*July*, 1945] was found not to occur.

C. TURNER

535.435 : 541.64

2587. Investigation of the scattering of light in solutions of polymers. E. FRISMAN AND K. KISELEVA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 221–4 (1950) *In Russian.*

Turbidity of solutions of high polymers was determined by means of a specially designed polarization nephelometer, and the average molecular weight was calculated in accordance with the formula of Blaker–Badger–Gilman [*J. Phys. Coll. Chem.*, **53**, 794 (1949)]. The asymmetry of scattering was also measured.

F. LACHMAN

535.435 : 541.64

2588. Light scattering by concentrated polymer solutions. P. DEBYE AND A. M. BUECHE. *J. Chem. Phys.*, **18**, 1423–5 (*Nov.*, 1950).

The light scattered by benzene solutions of polystyrene up to a volume fraction of polymer of 0·62 has been measured. The results are compared with what was to be expected on the basis of recent thermodynamic theories for polymer solutions. This comparison has led to the recognition of a new and rapid method for estimating molecular weights. The method also seems to be a convenient one for obtaining thermodynamic information. A.

535.435 : 541.64

2589. Effect of small refractive index differences between the solution and the solvent on light-scattering molecular weight. R. RIVEST AND M. RINFRET. Letter in *J. Chem. Phys.*, **18**, 1513–14 (*Nov.*, 1950).

535.435 : 541.64

2590. Absolute intensity of light scattering from pure liquids and solutions. C. I. CARR, JR. AND B. H. ZIMM. *J. Chem. Phys.*, **18**, 1616–26 (*Dec.*, 1950).

The absolute scattering powers of several strongly scattering solutions of polystyrene were measured by 3 independent methods, using transmission, integrated scattering and scattering at right-angles respectively. When a number of factors involving the geometry of the measuring system and the refraction of the light at interfaces are taken into account all the methods give results in excellent agreement. The absolute scattering power of benzene and CCl_4 were then determined by comparison with the polystyrene solutions and were found to be in good agreement with Einstein's theoretical equation, though at variance with most of the previously reported experiments. The scattering from solutions of dibenzyl and sucrose octaacetate were also measured and found to give results in good agreement with those calculated theoretically from the molecular weights of these substances. In the course of the measurements it was also necessary to study the reflection properties of $MgCO_3$ and MgO surfaces in more detail than has been published heretofore. A.

535.515 : 541.65

2591. Optical anisotropy in styrol polymers and methyl-methacrylate with an orientated particle arrangement. G. F. DALETSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 685–6 (1950) *In Russian.*

535.542.1

2592. Use of a half-shadow plate with uniform field compensators. H. G. JERRARD. *J. Sci. Instrum.*, **28**, 10–14 (*Jan.*, 1951).

The theory is given of a half-shadow arrangement, which consists of a muscovite mica plate mounted so as to cover half the field of view and so that it can rotate about an axis perpendicular to its plane. The arrangement can be employed with any uniform field compensator which is used between crossed polarizer and analyser. It has been studied with Soleil compensators and in particular with one which consists of two wedges, cut as for a Babinet compensator, but arranged with their thick ends adjacent. Some theoretical aspects of this "reversed Babinet" compensator are given and the effect of inaccurate orientation of the optic axes mentioned. An expression for the half-shadow sensitivity is obtained from a general expression for sensitivity in which the response characteristics of the eye are taken into account. A.

535.8

2593. Apparatus for the optical projection of the filament of an electrometer. K. S. VULFSON. *J. Tech. Phys., USSR*, **20**, 758–9 (*June*, 1950) *In Russian.*

The apparatus was specially designed for the electrometer of a Zeiss recording photometer and is based on the auto-collimating principle. It is, however, universally useful, as only the microscope of the electrometer has to be removed and replaced by the simple projecting apparatus. The source of light is a 200 W Hg lamp. B. F. KRAUS

535.824

2594. Phase contrast systems in colour. H. WOLTER. *Naturwissenschaften*, **37** (*No.* 21) 491 (1950) *In German.*

A short note describing 3 methods of translating phase or amplitude differences arising from an object in a microscope into colour differences in the image.

R. W. FISH

535.824 : 539.211

2595. A phase contrast method for the study of the state of polish of single glass surfaces. J. V. RAMSEY. *J. Sci. Instrum.*, **28**, 24–5 (*Jan.*, 1951).

Consists of reflection of a spherical wave from the surface to be examined, with a phase retarding spot placed at the focus of the reflected wave. A lens forms the image of the surface under test which is seen in phase contrast. Details of the apparatus and of the phase retarding plate are given and sample photographs shown. R. W. FISH

HEAT 536

536.21

2596. Solution of the equation of thermal conduction with a non-homogeneous boundary condition. G. I. Barenblatt. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 201–4 (1950) *In Russian.*

536.21 : 536.63

2597. Equipment for the simultaneous determination of thermal conductivity and diffusivity of insulating materials using a variable-state method. L. N. Clarke and R. S. T. Kingston. *Aust. J. Appl. Sci.*, **1**, 172–87 (*June*, 1950).

Describes equipment for the simultaneous determination of thermal conductivity, diffusivity and specific heat by means of a variable-state method. A single test takes about 2 min, involves a temperature rise of 2°c, and with sorbent materials can be carried out at any temperature and moisture content. Various methods of computation of results are given and some sources of error have been investigated. A.

536.21 : 541.64

2598. The thermal conductivity of elastomers under stretch and at low temperatures. T. M. Dauphinee, D. G. Ivey and H. D. Smith. *Canad. J. Res. A*, **28**, 596–615 (*Nov.*, 1950).

Heat conductivity of natural rubber and GR–S was studied in the range from + 50°c to − 170°c and from 0 to 100% stretch. The apparatus used was a greatly modified version of one designed by Schallamach. The conductivity of both types of rubber at 0% stretch lies in the range between $3{\cdot}5\times10^{-4}$ and $4{\cdot}0\times10^{-4}$ cal/sec cm deg c. Stretching increases the rate of change of conductivity with temperature of both natural rubber and GR–S, and decreases the conductivity of the latter. On lowering the temperature and raising it again natural rubber exhibits a complicated hysteresis phenomenon, while GR–S shows a hysteresis loop caused by a 2nd-order transition near the brittle point. The hysteresis phenomena of both types of rubber near the 2nd-order transition temperature shows considerable similarity to the changes in specific heat observed by Bekkedahl and co-workers. Above and below the transition region the heat conductivity decreases approximately linearly with temperature as might be expected from classical theory. The variation through the 2nd-order transition does not agree with classical theory, but may be explained qualitatively on the basis of a diffuse lambda-type transition. A.

536.21.08 : 548.0

2599. A method for measuring the thermal conductivity of small samples of poorly conducting materials such as optical crystals. S. S. Ballard, K. A. McCarthy and W. C. Davis. *Rev. Sci. Instrum.*, **21**, 905–7 (*Nov.*, 1950).

Thermal conductivities of from 2 to 500×10^{-4} c.g.s. units are measured by comparing the flow of heat through a given sample with that through a standard material. An accuracy of about 5% is estimated for this method. The dimensions of the apparatus limit the face size of both the unknown and standard samples to a maximum of 10 mm square; thicknesses of 2 to 10 mm are suitable. Values at average temperatures between 30°c and 75°c are reported for: NaCl, KCl, KBr, CaF_2, LiF (both air-grown and vacuum-grown), AgCl, Tl(Br, I), Tl(Br, Cl) and fused silica. A.

536.212

2600. Thermal conductivity of barium strontium oxide. G. F. Weston. Letter in *Nature, Lond.*, **166**, 1111–12 (*Dec.* 30, 1950).

Previous results of Clausing and Ludwig and Patai and Tomaschek are based on optical temperature measurements likely to be in error. In the new method a layer of oxide is produced on the top surface of a Ni block containing a heating element and a second Ni block covers the oxide. The temperature gradient between the two blocks is measured with thermocouples and the conductivity calculated from the heat loss of the top disk. Results obtained are much lower than those previously reported.

E. H. Dock

536.212.2

2601. An air-flow analogy for the solution of transient heat conduction problems. M. B. Coyle. *Brit. J. Appl. Phys.*, **2**, 12–17 (*Jan.*, 1951).

This method has been developed primarily for the solution of transient heat conduction problems in which the specific heat and thermal conductivity of the medium are functions of temperature. In these cases it constitutes an alternative to the more familiar resistance-capacity analogy since variations of specific heat and conductivity may be simulated automatically by a preliminary setting-up procedure. The paper summarizes the principles of the method and gives a brief description of the small prototype unit so far constructed. A.

536.23

2602. The pressure dependence of the thermal conductivity of polyatomic gases at 0°c. W. G. Kannuluik and H. B. Donald. *Aust. J. Sci. Res. A*, **3**, 417–27 (*Sept.*, 1950).

A form of "hot wire" apparatus is described in which the hot wire is replaced by a thin-walled Ni tube $\frac{1}{8}$ in dia. mounted in a similar Ni tube $\frac{1}{4}$ in dia. The gas under investigation occupies the narrow annular space between the two tubes. It is shown that the apparatus is completely free from convection up to pressures somewhat greater than 1 atm. and that the temperature discontinuity effect is inappreciable down to pressures of a few cm Hg. The apparatus is used to test the pressure dependence of the thermal conductivity of several polyatomic gases. The thermal conductivity (at 0°c) of the gases CO_2 and CH_4 is found to increase slowly with the pressure over the range 10–80 cm Hg. It is suggested that this effect may be taken as evidence of the incomplete participation of the energy of vibration of the molecules in the conduction process. A.

536.24

2603. The problems of the flux distribution in composite thermal systems and their solution on electrical models. G. L. Polisar and V. Ya. Khasilev. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 243–6 (1950).

536.332

2604. Radiation correction and the law of cooling. Om Prakash, S. Lal and B. Singh. Letter in *Curr. Sci.*, **19**, 310–11 (*Oct.*, 1950).

536.413 : 539.26

2605. Concerning reported discrepancies between X-ray and macroscopic measurements of thermal expansion of some alkali halides. L. F. Connell, Jr. and H. C. Martin, Jr. Note in *Acta Cryst.*, **4**, 75–6 (*Jan.*, 1951).

536.413 : 548.0

2606. Thermal dilation of copper. D. S. Eppelsheimer and R. R. Penman. *Physica*, **16**, 792–4 (*Oct.*, 1950).

The prediction that certain cubic metals may not be precisely cubic throughout a range of temperature below their melting-points led to the present investigation. Pure Cu was chosen as the cubic metal to examine for anisotropy in its thermal dilation, and the (024) and the (331) planes were chosen in the lattice. Temperatures for examination ranged between 18°–770°C, using a 19 cm high-temperature powder camera. Plotting the lattice constant *v.* temperature, the thermal dilation of pure Cu was found to be isotropic throughout the temperature range investigated. A.

536.42

2607. The theory of changes of state. H. N. V. Temperley. *Sci. Progr.*, **39**, 27–40 (*Jan.*, 1951).

A review of theories of change of state. The general thermodynamic equations are developed and transformations of state classified according to the behaviour of the latent heat and the differential coefficients of the thermodynamic potential. Van der Waals' theory is outlined; the main features necessary in any liquid model and the different attempts to realize these are examined. Finally a brief account is given of the application of statistical mechanics to the problem, with a discussion of how such theories may lead to the prediction of metastable states. F. E. HOARE

536.422.1

2608. I. The vaporization of strontium oxide. G. E. Moore, H. W. Allison and J. D. Struthers. *J. Chem. Phys.*, **18**, 1572–9 (*Dec.*, 1950).

The vapour pressure of SrO was measured by studying the product evaporated from Pt filaments coated with SrO. Most of the experiments employed radiactive isotopes. The possibility of systematic error caused by chemical reduction of the oxide or by its thermal dissociation is discussed.* A value of λ_0, the heat of evaporation at 0°K computed from the results, is used to evaluate precision and to derive a vapour-pressure equation. [See also Abstr. 3117 (1951)]. A.

536.423.1

2609. The theory of open-tube distillation column. M. Bertrand and M. Rinfret. Letter in *J. Chem. Phys.*, **18**, 1510–11 (*Nov.*, 1950).

536.423.1

2610. Applications of diffusion theory to evaporation from droplets and flat surfaces. G. Luchak and G. O. Langstroth. *Canad. J. Res. A*, **28**, 574–9 (*Nov.*, 1950).

It has been customary in applications of diffusion theory to evaporation problems to consider the liquid surface as fixed in solving for the vapour distribution in the adjacent space. A more rigorous treatment, involving solution of the diffusion equation with moving boundaries, has been applied to the problem of evaporation from droplets and flat surfaces. The results indicate that the equations obtained by the method of quasi-stationary states are good to a high degree of approximation under ordinary circumstances. A.

536.423.1

2611. The evaporation of droplets in still air. G. O. Langstroth, C. H. H. Diehl and E. J. Winhold. *Canad. J. Res. A*, **28**, 580–95 (*Nov.*, 1950).

The evaporation of droplets of 1 to 2 mm dia. into still air has been studied with 9 liquids forming a series of graded volatility from toluene to aniline and including water. The experimental results agreed with calculations based on diffusion and heat transfer theory. The surface temperature of the more volatile droplets was found to be significantly lower than the bulk temperature, in contrast to Johnson's results for water. Convection effects were found to be present with 43 mm dia. evaporation vessels in confirmation of Gilliland's suggestion, but were absent in the smaller vessels used in the main investigation. A.

536.424

2612. Some physical properties of nickel amalgams. J. Jaffray and J. Cariat. *C.R. Acad. Sci., Paris*, **231**, 1128–30 (*Nov.* 20, 1950) *In French.*

Measurements of resistance, thermoelectric properties and specific heat of dilute Ni amalgams have shown that in each case there is an abrupt irreversible change occurring near 220°C. These results are in agreement with those of Bates and others [*Proc. Phys. Soc., Lond.*, **51**, 419–24 (*May*, 1939); **52**, 425–51 (*July*, 1940)] for resistance and susceptibility. It is suggested that the phenomena may be associated with a change from hexagonal to cubic Ni since Michel has found that a non-ferromagnetic hexagonal form with C or N in the lattice changes irreversibly to a cubic ferromagnetic form at 210° or 190°C respectively. F. E. HOARE

536.424

2613. On anomalous phase change of ammonium nitrate NH_4NO_3. R. Ueda and T. Ichinokawa. Note in *J. Phys. Soc. Japan*, **5**, 456–7 (*Nov.–Dec.*, 1950).

Dilatometric and calorimetric experiments show that the phase change II → III, whch normally takes place reversibly at ~ 80°C, may be depressed and take place irreversibly at ~ 50°C. A. J. C. WILSON

536.425

2614. Temperature dependence of the stability of a supercooled phase. N. N. Sirota. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 5) 971–4 (1950) *In Russian.*

Reference is made to a previous paper [*ibid.*, **39** (*No.* 8) (1943)]. The applicability of Kolmogorov's relationship [*Izv. Akad. Nauk, SSSR, Ser. Mat.* (*No.* 3) (1937)] is discussed in connection with the influence of the uniformity of the growth rate of the new phase. In eutectoid transformations the rate of

formation of seeds is greater for the phase for which the overall energy of seed formation is smaller. This phase is called the "leading phase." F. LACHMAN

536.425

2615. On two types of S-shaped curves of the stability of a supercooled phase. N. N. SIROTA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 6) 1105–8 (1950) *In Russian.*

Reference is made to papers by V. D. Sadovskiĭ [*Izv. Akad. Nauk, SSSR, Otdel. Tekhn. Nauk* (*No.* 3) 219 (1945)] and by the author [*Dokl. Akad. Nauk, SSSR*, **39** (*No.* 8) (1943)]. The problem of the existence of 2 types of the S-shaped stability curves is discussed in connection not only with the change in the composition of the new phase at different degrees of supercooling, but also with the part played by the structural resemblance between the original phase and the new phase in accordance with the principle of the dimensional and orientational correlation. Systems having one, and more than one, component are discussed. The complex type of the S-shaped curves is due to the appearance of metastable compounds which have a different composition, and sometimes a different structure, from the stable compounds. F. LACHMAN

536.46

2616. On the mechanism of explosive burning of gaseous mixtures. M. V. POLYAKOV AND Y. V. ZHIGAĬLO. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1229–30 (1950) *In Russian.*

Experiments on the explosive burning of mixtures of CH_4 and O_2, in the presence of N_2 as a diluent, have shown that the concentration of NO in the products of combustion increases to a max. of 1·5–2·0% as pressure increases, and then falls to 0·4–0·5%, a value characteristic of burning in large vessels at atmospheric pressure. It is suggested that such a dependence of NO-yield upon pressure implies that burning is controlled by a chain reaction at low pressures, but that a thermal mechanism predominates as the pressure is increased. In favour of this hypothesis, experimental results on the effect of addition of $Pb(C_2H_5)_4$ are cited. For a mixture of 38% H_2, 40% O_2, 22% N_2 at 100 mm pressure, the yield of NO falls from approx. 0·85% to 0·04% if 0·0034% $Pb(C_2H_5)_4$ is added; the same addition of inhibitor causes the lower ignition limit to rise from 55 to 70 mm Hg. So marked an effect can only occur if the primary mechanism of flame propagation at low press. involves a chain reaction. A. SCHOFIELD

536.46

2617. Flame propagation. I. The effect of initial temperature on flame velocities of propane-air mixtures. G. L. DUGGER. *J. Amer. Chem. Soc.*, **72**, 5271–4 (*Nov.*, 1950).

The maximum flame velocity of propane-air mixtures increases from 47 cm/sec at 29° to 160 cm/sec at 343°. The rate of increase of velocity increases with temp. The results are independent of tube dia. in the range 10·2 to 22·2 mm and of stream flow Reynolds number in the range 1 500 to 2 100. Approximate calculations indicate that both the thermal theory as presented by Semenov (for bimolecular reactions) and the diffusion theory of Tanford and Pease predict that flame velocity will increase with temp. at an increasing rate. Relative increases in flame velocity predicted by the thermal theory are in satisfactory agreement with experimental results, while those predicted by the square root law are as much as 35% lower at the higher temperatures. A.

536.46

2618. A comparison of quenching distance and inflammability limit data for propane-air flames. D. M. SIMON. Letter in *J. Appl. Phys.*, **22**, 103 (*Jan.*, 1951).

536.46 : 535.338.3

2619. Spectroscopic studies of low-pressure flames. V. Evidence for abnormally high electronic excitation. A. G. GAYDON AND H. G. WOLFHARD. *Proc. Roy. Soc. A*, **205**, 118–34 (*Jan.* 22, 1951).

See Abstr. 5777 (1950) for part IV. Spectrum-line reversal measurements, using lines of Fe, Pb, Na and Tl, have been made for the reaction zones of many flames. For most organic flames the reversal temperatures exceed theoretical maximum temperatures, the values rising very high for lines in the u.v. Lines of Fe requiring up to at least 173 kcal/mole for their excitation are emitted from the reaction zones, but not from the interconal gases. Various hydrocarbons (CH_4, C_2H_4, C_2H_6, C_2H_2, C_3H_8), methyl alcohol, cyanogen and ammonia burning in premixed flames with O, air or N_2O all show this abnormally high electronic excitation, but flames of H_2, CO, CS_2 and formaldehyde do not. The H/N_2O flame does show some abnormal excitation, but of a different character. Diffusion flames at atmospheric pressure do not show the effect. Processes by which electronic excitation may occur are examined, and the cause of the abnormal excitation is discussed. The spectrum-line reversal method of measuring flame temperatures is criticized. A.

536.48

2620. Design and performance of a Joule–Kelvin helium liquefier. J. G. DASH, D. B. COOK, M. W. ZEMANSKY AND H. A. BOORSE. Note in *Rev. Sci. Instrum.*, **21**, 936–8 (*Nov.*, 1950).

Data are given for a liquefier of 540 ml capacity and a liquefaction rate of 1 l/hr. Experiments can be carried out inside the apparatus at temperatures down to 1·5°K. H. LONDON

536.48

2621. A float for liquid helium. J. BABISKIN. Note in *Rev. Sci. Instrum.*, **21**, 941 (*Nov.*, 1950).

536.48

2622. Some remarks concerning cooling by the mechano-caloric effect in helium. F. E. SIMON. *Physica*, **16**, 753–9 (*Oct.*, 1950).

The thermodynamic criteria for an effective cooling method are discussed and it is shown that no method using liquid He as the working substance can be efficient at temperatures much below 1°K. A.

536.48

2623. The influence of mutual friction between the two fluids in liquid helium II on the energy dissipation by an oscillating disc. G. C. J. ZWANIKKEN. *Physica*, **16**, 805–7 (*Oct.*, 1950).

536.48

2624. Some further experiments with an oscillating disc in liquid helium. P. L. SMITH. *Physica*, **16**, 808–11 (*Oct.*, 1950).

An attempt was made to show the existence of mutual friction between liquid He I and liquid He II. Such a friction should be observed as an increase in the damping coefficient of an oscillating disk when large amplitudes were employed. No such increase, however, was found. Preliminary experiments above the lambda-point roughly confirmed Mendelssohn's viscosity measurements made with a capillary tube. A.

536.48

2625. Oscillating disc experiments in liquid helium II. A. C. HOLLIS-HALLETT. Letter in *Proc. Phys. Soc., Lond.*, *A*, **63**, 1367–8 (*Dec.*, 1950).

For small velocities of the oscillating system, the log dec is independent of velocity, and the values obtained for the viscosity and density of the normal fluid of He II agree with those of Andronikashvili. When the peripheral velocity exceeds a value about 100 times less than the critical value associated with film flow, the log dec increases with velocity. It is suggested that this effect might be explained by a mutual frictional force, but not by turbulence.

R. B. DINGLE

536.48

2626. Pressure measurement in superflow. R. BOWERS, B. S. CHANDRASEKHAR AND K. MENDELSSOHN. *Phys. Rev.*, **80**, 856–8 (*Dec.* 1, 1950).

The pressure of flowing liquid He II has been measured in the capillary link as well as on its ends. Flow under gravitational and thermal potential has been studied in narrow slits and tubes packed with fine powder. On the basis of ordinary pressure measurement the results are not consistent and it is concluded that the definition of "pressure" in superflow requires additional parameters. A.

536.48

2627. Two-fluid theory of liquid helium II below 1°K. S. NAKAJIMA AND M. SHIMIZU. Letter in *Phys. Rev.*, **80**, 923 (*Dec.* 1, 1950).

Calculation of second-sound velocity on the basis of Abstr. 7954 (1950), assuming transfer of the phonon entropy by the superfluid flow. The result disagrees with recent experiments by Atkins and Osborne [Abstr. 1017 (1951)]. H. LONDON

536.48

2628. A medium capacity helium liquefier. G. R. HERCUS AND G. K. WHITE. *J. Sci. Instrum.*, **28**, 4–6 (*Jan.*, 1951).

A Linde He liquefier of simple construction is described. The expansion valve and collecting vessel are vacuum insulated and are contained in the dewar flask holding the liquid H. The liquid-O cooling stage is combined with a charcoal cleaner in a separate dewar vessel. Liquid He is transferred from the 1¼ l collecting vessel through a vacuum-insulated metal siphon into a transport vessel. A.

536.48 : 531.717

2629. The thickness of the helium film. E. J. BURGE AND L. C. JACKSON. *Proc. Roy. Soc. A*, **205**, 270–84 (*Feb.* 7, 1951).

A description of an optical method for determining the thickness of the He II film. Linearly polarized light is reflected from a stainless steel mirror, the upper part of which is coated with a layer of Ba stearate 1 molecule thick and the lower part with a similar layer 3 molecules thick. The reflected light passes through a mica compensating plate and a Nicol prism. Adjustment of the mica plate and Nicol gives equality of illumination on the "1" and "3" areas. If now a film of He II covers the mirror the Nicol must be rotated to restore equality of illumination. The rotation is a measure of the thickness of the He film, the relation between the two quantities being calculated in terms of the angle of incidence and the optical constants of liquid He, Ba stearate and stainless steel. The observed thickness at any given height above the liquid He was found to be nearly independent of the temperature between 1·1 and 2·18°K, but then decreased rapidly to zero at the λ-point. In the formula $d = k/h^{1/z}$ for the thickness d at height h cm for any given temperature, the value of z varies from 3·5 at 1·1°K to 2·5 at 2·1°K. The thickness at 1 cm and 1·5°K is provisionally given as $1{\cdot}9 \times 10^{-6}$ cm. A.

536.48 : 534.21

2630. Second sound in He^3–He^4 mixtures. E. A. LYNTON AND H. A. FAIRBANK. *Phys. Rev.*, **80**, 1043–6 (*Dec.* 15, 1950).

Second sound has been investigated in He^3–He^4 mixtures for He^3 concentrations between 0·09% and 0·80% in the temperature range between 1·24°K and 1·95°K. The velocity of second sound was found to increase markedly with increasing concentration; e.g. at 1·26°K, the velocity with the 0·80% concentration was 26·52 m/sec as compared to 19·08 m/sec for pure He^4. The results of these experiments are compared with the theoretical predictions of Pomeranchuk. A.

536.48 : 534.21

2631. Second sound in liquid helium II. D. V. OSBORNE. *Proc. Phys. Soc., Lond., A*, **64**, 114–23 (*Feb.*, 1951).

A pulse technique for the propagation of second sound is described and the expected shape of the received pulse is discussed. In this connection, experimental evidence has been obtained for a temperature discontinuity at the interface between liquid helium II and a solid medium at second sound frequencies. The pulse method has been used to study the attenuation of second sound with distance and the formation of shock waves. The observations on the latter are shown to be in agreement with the predictions of the equations of motion of liquid helium II if second order terms are not neglected. A.

536.48 : 534.22

2632. On the velocity of second sound in liquid helium II. H. N. V. TEMPERLEY. *Phil. Mag.*, **42**, 74–81 (*Jan.*, 1951).

Some recent experiments by Atkins and Osborne [Abstr. 1017 (1951)] give values for the velocity of second sound at very low temperatures in close agreement with Landau's (1941) predictions. It is shown that such results cannot be obtained from any theory of Tisza–London type, unless it is postulated that other states besides the very lowest one contribute to

ρ_s, the density of superfluid. Landau's (1941) method of calculating ρ_s can be applied to any model and does imply such a postulate. It is concluded that the experimental results only throw light on the correct method of calculating ρ_s and cannot be regarded as evidence in favour of Landau's quantum hydrodynamics. On the other hand, the fact that liquid He^3 does not show superfluid properties can no longer be regarded as evidence against Landau's theory, as the predictions of the Landau and Tisza–London types of theory are identical for both the perfect Bose–Einstein and the perfect Fermi–Dirac gases. A.

536.48 : 534.222.2

2633. The theory of the propagation in liquid helium II of "temperature-waves" of finite amplitude. H. N. V. Temperley. *Proc. Phys. Soc., Lond., A*, **64**, 105–14 (*Feb.*, 1951).

The two-fluid model of liquid helium II is applied to the problem of predicting the behaviour of waves and pulses of second sound of finite amplitude. It is found that equations quite analogous to the Riemann and Rankine–Hugoniot equations for ordinary sound waves and shock fronts can be established. These equations predict the "overtaking effect" with the establishment of a "temperature-shock" for pulses of second sound of finite amplitude. The temperature-shocks should be of "front-edge" type (propagation of an abrupt rise in temperature) if the liquid helium is at a temperature below 1·96°K, but should become "back-edge," corresponding to an abrupt fall in temperature, between 1·96°K and the λ-point. There is experimental evidence in support of both these predictions. It is shown that, just as for ordinary shock fronts, the irreversible effects due to the passage of a temperature shock should be proportional to the cube of the height of the shock. A.

536.48 : 536.21

2634. The thermal conductivity of solid helium. K. R. Wilkinson and J. Wilks. Letter in *Proc. Phys. Soc., Lond., A*, **64**, 89–91 (*Jan.*, 1951).

A tube was filled with liquid He sufficiently compressed for the solid obtained on cooling to fill the tube completely. Under the experimental conditions used, the thermal conductivity at constant density was of the form $K\alpha e^{\theta/2T}$, giving values of the Debye temperature θ similar to those from specific heat measurements, and varying similarly with density. A maximum in K at lower temperatures is predicted. A discussion is given of a possible heat-switch.

R. B. DINGLE

536.48 : 536.22

2635. Heat conductivity of liquid helium I. R. Bowers and K. Mendelssohn. Letter in *Nature, Lond.*, **167**, 111 (*Jan.* 20, 1951).

There is no appreciable rise as the λ-point is approached. The temperature dependence is roughly $\propto 1/T$. H. LONDON

536.521

2636. Progress in the field of optical pyrometry 1940–50. J. Euler. *Z. angew. Phys.*, **2** (*No.* 12) 505–9 (1950) *In German.*

A review with 54 references to the literature.

536.53

2637. A noncontact temperature measuring device. J. E. Field and S. D. Gehman. Letter in *J. Appl. Phys.*, **22**, 106 (*Jan.*, 1951).

A simple radiation thermocouple receiver is described, for measuring the temperature of moving objects (e.g. rolls, belts, etc.). It is placed close enough to the object to approach temperature equilibrium, and reduces the dependence on the emissivity of the object. Compensation for ambient temperature is effected by another pair of couples. Typical measurements were made to $\pm$ 2°F in the range 140–180°F, 80% of response being reached in 5 sec.

536.531 : 541.126

2638. Some extensions in the use of resistance thermometry in the study of gaseous explosions. A. S. Leah, C. Rounthwaite and D. Bradley. Letter in *Phil. Mag.*, **41**, 1289–91 (*Dec.*, 1950).

536.532 : 621.317.39

2639. Multi-channel apparatus for recording temperatures. W. I. J. Price and J. J. Trott. *J. Sci. Instrum.*, **28**, 15–17 (*Jan.*, 1951).

The apparatus described was developed for investigating temperature gradients in various road surfacings and subgrades, an experiment involving continuous recording from 60 thermocouples. These were arranged in 2 groups of 30, and each thermocouple was connected in succession at ½-min intervals with a chopper unit rendering the e.m.f. intermittent. A selector mechanism was used to connect the thermocouples, and the intermittent e.m.f.'s resulting from chopping were fed to a conventional resistance-capacitance amplifier, rectified, and then fed to the appropriate channel of a 2-channel pen recorder. This arrangement recorded the readings of each thermocouple every ½ hr for continuous periods up to 100 hr. A.

536.587

2640. A method of temperature programme control for thermal analysis. J. G. Ball and E. T. Adams. *J. Sci. Instrum.*, **28**, 47–9 (*Feb.*, 1951).

A method of controlling the energy input to a system to give a pre-arranged temperature programme is described. The method involves rotating a variable transformer spindle at various angular rates by means of a cam and is particularly useful for systems of small heat capacity. A.

536.631

2641. Investigation of the specific heat of the ferromagnetic chromium sulphide. I. G. Fakidov and N. P. Grazhdankina. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 1) 19–20 (1950) *In Russian.*

536.631 : 536.424.1 : 548.7

2642. Anomalous specific heat and molecular rotation in normal solid alcohols. Y. Kakiuchi, T. Sakurai and T. Suzuki. *J. Phys. Soc. Japan*, **5**, 369–75 (*Sept.–Oct.*, 1950).

The specific heats of tetradecyl and hexadecyl alcohol are observed near the transformation point. The specific heat anomaly exists at 20°C when lattice transformation due to rotational transitions occurs, and an increase in the dielectric constant begins. With purification the transformation point shifts to

higher temperature, the anomaly becomes sharper, and the effect of previous thermal treatment decreases. Cogwheel-like rotation is suggested in the rotational, disordered state. J. JACOBS

536.633.2

2643. The specific heat at constant volume of carbon dioxide in the neighbourhood of the critical point. A. MICHELS AND J. C. STRIJLAND. Letter in *Physica*, **16**, 813–14 (*Oct.*, 1950).

536.66

2644. The heat of dissociation of carbon monoxide. G. GLOCKLER. Letter in *J. Chem. Phys.*, **18**, 1517–18 (*Nov.*, 1950).

536.66

2645. The heat of dissociation in nitrogen. G. GLOCKLER. Letter in *J. Chem. Phys.*, **18**, 1518 (*Nov.*, 1950).

THERMODYNAMICS 536.7/.8

536.7 : 538.224 : 548.7

2646. $ZnSO_4.7H_2O$. $ZnSO_4.6H_2O$. Heat capacities, entropies and crystal perfection at low temperatures. Heats of solution and transition. R. E. BARIEAU AND W. F. GIAUQUE. *J. Amer. Chem. Soc.*, **72**, 5676–84 (*Dec.*, 1950).

The heat capacities have been measured from 15–300° K, and heats of solution determined at 25°. The measurements on $ZnSO_4.6H_2O$ were complicated by an irreversible effect which is discussed. The heat of transition of $ZnSO_4.7H_2O$ to form $ZnSO_4.6H_2O$ and saturated solution at 38·12°, the transition temperature, has been found to be 4 017 cal $mole^{-1}$. The entropy of $ZnSO_4.7H_2O$ less nuclear spin and isotope effects, equals 92·9 cal deg^{-1} $mole^{-1}$ at 298·16°, which agrees closely with a value obtained indirectly by means of the Clark cell. A.

536.7 : 538.224 : 548.7

2647. Crystal perfection of $ZnSO_4.7H_2O$. Partial molal heat capacity, heat content and vapor pressure of its aqueous solutions. Thermodynamics of Clark cell. W. F. GIAUQUE, R. E. BARIEAU AND J. E. KUNZLER. *J. Amer. Chem. Soc.*, **72**, 5685–90 (*Dec.*, 1950).

These have been determined over the range 25 to 35°. The Clark cell has been treated thermodynamically and the partial pressure of water over saturated $ZnSO_4$ solutions has been determined. Various calorimetric and cell data have been combined to show that $ZnSO_4.7H_2O$ attains perfect order at 0°K. A.

536.71

2648. Lennard–Jones and Devonshire equation of state of compressed gases and liquids. R. H. WENTORF, JR., R. J. BUEHLER, J. O. HIRSCHFELDER AND C. F. CURTISS. *J. Chem. Phys.*, **18**, 1484–500 (*Nov.*, 1950).

The reduced equation of state for compressed gases and liquids is computed according to the theory of Lennard-Jones and Devonshire for a large number of temperatures and densities. The corrections due to gas imperfection of internal energy, specific heat and entropy as well as the compressibility factor (pv/RT) are expressed in terms of reduced variables. The calculations were made by punched-card methods. A comparison is made between experiment and theory. It is shown that the theory of Lennard–Jones and Devonshire is unsatisfactory at densities near the critical point and lower but improves at higher densities becoming better for normal liquids. Such results were to be expected from the nature of the cell or free-volume method. A.

536.75

2649. Thermodynamic functions for fluorine. G. M. MURPHY AND J. E. VANCE. Letter in *J. Chem. Phys.*, **18**, 1514–15 (*Nov.*, 1950).

536.753

2650. Entropies of vaporization, and internal order in liquids. L. A. K. STAVELEY AND W. I. TUPMAN. *J. Chem. Soc.*, 3597–606 (*Dec.*, 1950).

For each of 53 liquids, the entropy of vaporization is estimated over as wide a range of temperature as possible up to the normal boiling-point. These entropy changes are compared according to Hildebrand's rule, and the alternative method of comparison suggested by Pitzer is briefly discussed. A plot of entropy of vaporization against a convenient measure of the molar volume of the vapour for the class of liquids having monatomic or highly symmetrical molecules is used to establish empirically a reference curve, representing the lowest possible values of the vaporization entropy. An attempt is made to interpret the excess entropy over the values furnished by the reference curve in terms of the degree of order in the liquids and the extent to which molecular rotation therein is inhibited, making qualitative use of Pitzer's analysis of the thermodynamic properties of restricted rotators. Among the molecular properties considered are the moment of inertia, polarity, length of the carbon chain in paraffins, and the presence in such a chain of double bonds. A.

536.773

2651. On the unorthodox versions of the Le Chatelier–Braun principle. Z. KLEMENSIEWICZ. *Physica*, **16**, 795–804 (*Oct.*, 1950).

The different formulations of the unorthodox version of the Le Chatelier–Braun principle, as presented by Ehrenfest, Planck, Mmes Ehrenfest-Afanasjewa and de Haas-Lorentz, and Epstein are discussed. It is shown that they cover a narrow field only, whereas the orthodox formulation, as explained previously [Abstr. 949 (1950)] applies to all possible systems in equilibrium. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

2652. Screening of electronic interactions in a metal. D. BOHM AND D. PINES. Letter in *Phys. Rev.*, **80**, 903–4 (*Dec.* 1, 1950).

The interaction of charges in an electron gas of high density has been considered, and it has been shown that the Hamiltonian can be split up into two

parts: (i) The "plasma oscillations" of the medium as a whole. These resemble sound waves and include the long-range part of the Coulomb interactions; their excitation is negligible at low temperatures. (ii) A "screened" Coulomb interaction

$$e^2 r_{ij}^{-1} \exp(-\lambda r_{ij}).$$

The theoretical formula for λ agrees with its value as obtained from the soft X-ray emission band of Na [Abstr. 2482 (1950)] and Wohlfarth's work on the specific heat of free electrons in metals [Abstr. 6467 (1950)]. Details of the calculation are reserved for later publication. P. T. LANDSBERG

537.12 : 548.0

2653. The mobility of electrons in diamond. C. C. KLICK AND R. J. MAURER. *Phys. Rev.*, **81**, 124–30 (*Jan.* 1, 1951).

The mobility of electrons in diamond has been measured by means of the Hall effect. In agreement with the theory of Seitz, the mobility is inversely proportional to the three-halves power of the absolute temperature. The measured room temperature value of the mobility is 900 cm²/volt-sec as compared with the theoretical estimate of 156 cm²/volt-sec. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.212

2654. Some linear and planar problems of steady potential field for a variable coefficient of conductivity. L. S. EĬGENSON. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 53–4 (1950) *In Russian.*

537.212 : 537.311.33 : 621.317.329

2655. Mapping electric fields with the help of semi-conducting sheets. W. CLAUSSNITZER AND H. HEUMANN. *Z. angew. Phys.*, **2** (*No.* 11) 443–6 (1950) *In German.*

A modification of the electrolytic trough method is described, in which the electrolyte is replaced by a thin sheet of a solid semi-conducting material, e.g. paper impregnated with graphite. C. A. HOGARTH

537.22 : 541.182.3

2656. Note on static electrification of dust particles on dispersion into a cloud. J. E. COOLIDGE AND G. SCHULZ. **Comment on static electrification of dust particles on dispersion into a cloud.** W. B. KUNKEL. Letters in *J. Appl. Phys.*, **22**, 103–4 (*Jan.*, 1951).

See Abstr. 7223 (1950). Attention is drawn to earlier work [Whitman, *Phys. Rev.*, **28**, 1287 (1926)] which is in agreement. Kunkel gives added explanation.

537.221

2657. Experiments with a Geiger point counter on worked non-metals. J. KRAMER. *Z. Phys.*, **128** (*No.* 4) 538–45 (1950) *In German.*

Experiments with a point counter, in which the plane electrode contained a non-metallic specimen, were made. The specimens were found to emit electrons on being rubbed or shattered and the time-variations of this emission were studied for a wide range of substances. A brief discussion of the physical mechanisms involved is given. J. D. CRAGGS

537.221

2658. The Volta effect as a cause of static electrification. W. R. HARPER. *Proc. Roy. Soc. A*, **205**, 83–103 (*Jan.* 22, 1951).

An experimental investigation of the static electrification of metal/metal surfaces shows that the erratic results normally obtained are owing to there being more than one cause, and that the complete elimination of rubbing leaves an effect that is amenable to quantitative measurement. This "separation charging" is shown to be related to the contact potential, and to have the characteristics to be expected if the Volta–Helmholz hypothesis of its origin is correct. The importance of this explanation of tribo-electrification has long been debated. The supposition that the hypothesis predicts negligible charging of conductor/conductor surfaces is shown to be based on an inadequate understanding of the significance of surface topography at the points of contact. By paying proper attention to this, and revising the hypothesis to allow for the transfer of electrons by tunnel effect, a precise theory of separation charging is derived. When applied to the experiments, agreement within the limits of experimental error is obtained, without the introduction of disposable constants. A.

537.222.2

2659. An apparatus for the study of electrets. L. A. FREEDMAN AND L. A. ROSENTHAL. *Rev. Sci. Instrum.*, **21**, 896–7 (*Nov.*, 1951).

An apparatus capable of continuously measuring and recording electret strength is described. It consists of a mechanically driven condenser whose induced voltage, due to the electric field of the electret, is filtered, amplified and applied to a recorder. Some experimental observations of the transition from heterocharge to homocharge are presented. A.

537.224 : 621.3.011.4

2660. Calculation of the electrical capacitance of a cube. D. K. REITAN AND T. J. HIGGINS. *J. Appl. Phys.*, **22**, 223–6 (*Feb.*, 1951).

The basic theory of calculation of the capacitance of a given geometrical configuration by the use of subareas is advanced and applied to determine accurately the capacitance C of a cube of side a. The best previously published determination is $0{\cdot}6221a < C < 0{\cdot}71055a$. The value obtained of $C \simeq 0{\cdot}655a$ e.s.u. is both a lower limit and very close to the exact value. A.

537.226

2661. "Artificial matter" for e.m. waves. T. SAKURAI. *J. Phys. Soc. Japan*, **5**, 394–8 (*Nov.–Dec.*, 1950).

Periodic structures are considered of period small with respect to the wavelength. Macroscopic average field vectors are introduced, defined as the average of the microscopic vectors over the volume of the unit cell. For the macroscopic field the body behaves as if it were made of uniform material ("artificial matter"). Results are also applicable to bodies of statistically uniform structure. Some applications are given, in particular to spherical particles arranged in a cubic structure. If the spheres are metallic, the artificial matter has an apparent dielectric constant

$= \varepsilon_0(1 + 4\pi r^3/V)$ (V = volume of unit cell; r = radius of spheres). This artificial dielectric is called "metal balls dielectric." L. PINCHERLE

537.226.08 : 621.317.374 : 621.317.335.3

2662. Film method of determining the dielectric constant and the loss angle in the cm wave range. I. A. ELTSIN. *J. Tech. Phys., USSR*, **20**, 735–7 (*June*, 1950) *In Russian.*

An extension to cm waves of Roberts and v. Hippel's method of measuring the h.f. dielectric constant and loss angle of a dielectric by placing a film of the tested material in a waveguide excited by the H_{01} wave. It is shown that the difficulties experienced by earlier workers can be overcome by placing the film a quarter-wavelength from the closed end of the waveguide instead of at the end. Full sensitivity is reached without requiring particularly powerful generators or especially sensitive detectors. Alternatively, Rozhanskiĭ's method [Abstr. 1895 (1949)] may be used, in which the waveguide is tuned by piston displacement to resonance with the generator, the film then placed into the antinode of the electric field and resonance again obtained. The dielectric constant and loss angle can be calculated from the length variation of guide between resonance positions, variation of width of response curve and film thickness. This method is also applicable when the measuring system is a coaxial feeder. B. F. KRAUS

537.226.1

2663. Atom polarisation. I. The solvent-effect theory and its application to the molecular refraction and polarisation of *n*-paraffins in the liquid state. A. AUDSLEY AND F. R. GOSS. *J. Chem. Soc.*, 2989–97 (*Nov.*, 1950).

By means of new measurements of the refractive indices and dielectric constants of all the *n*-paraffins from *n*-pentane to *n*-heptadecane, and by application of the solvent-effect theory, it is possible to express molecular refractions and polarizations in both the liquid and the gaseous state in terms of series and constitutive constants of both electron and atom polarization for the various bonds and atoms, and also in terms of anisotropic factors associated with them in the liquid state. These anisotropic factors are related to the size and shape of the molecules in a manner precisely analogous to the solvent-effect constants which determine the magnitude of the solvent-effect in dipole-moment measurements by the solution method. A.

537.226.1.08 : 621.315.618 : 621.317.335.3

2664. Microwave measurements of the dielectric properties of gases. G. BIRNBAUM, S. J. KRYDER AND H. LYONS. *J. Appl. Phys.*, **22**, 95–102 (*Jan.*, 1951).

An accurate and sensitive method for measuring the complex dielectric constant ($\varepsilon' - i\varepsilon''$) of gases in the microwave region is described and critically investigated for sources of error. A resonant-cavity method is used in which the cavity response curve is displayed on a cathode-ray tube. The variation of resonance frequency and Q of the cavity when filled with gas are determined from measurements with two frequency markers. The equipment is operated at 9 000 Mc/s and cavities with Q's of 1×10^4 are used. In the determination of $\varepsilon' - 1$ (dimensionless) of very low loss gases, an accuracy of 0·4% and a sensitivity of 4×10^{-7} can be obtained. In the determination of the loss factor ε'', an accuracy of 2% and a sensitivity of 5×10^{-7} can be obtained. This method is useful for measuring dispersion and absorption in solids and liquids as well as gases. Experimental results are given and briefly discussed for $\varepsilon' - 1$ of O_2, N_2, CO_2, He and air, and for ε'' of NH_3 as a function of pressure up to 20 cm Hg. A.

537.226.2

2665. Dielectric constants of aqueous solutions of dextrose and sucrose. C. G. MALMBERG AND A. A. MARYOTT. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 299–303 (*Oct.*, 1950).

The dielectric constants of aqueous solutions of dextrose and of sucrose prepared from NBS Standard Samples were determined at 20°, 25° and 30°c for concentrations up to 50 and 60% by weight, respectively. A bridge method was used, and the sources of error involved are considered. The results, relative to a selected value for water, are considered to be accurate to 0·05% or better and are expressed in terms of an empirical equation for the purposes of interpolation. A.

537.226.2

2666. A review and discussion of dielectric constants of ionic crystals. B. SZIGETI. *Rep. Brit. Elect. Res. Ass., Ref. L/T*222, 5 *pp.* (1950).

The experimental data relating to those properties of ionic crystals which are connected with their dielectric constants are discussed in the light of a recently derived relation. Several conditions must be favourable for a large dielectric constant to occur; only in crystals of intermediate polarity can all these conditions be favourable. A.

537.226.2

2667. A relation between dielectric constant and loss angle of ferro-electric materials. M. KORNETZKI. *Z. angew. Phys.*, **2** (*No.* 11) 446–8 (1950) *In German.*

Assuming that a relation similar to that laid down by Raleigh for magnetization in ferromagnetic materials in weak fields holds also for the polarization of ferro-electric materials, it is shown that a linear increase of dielectric constant and power factor with increasing field strength should be obtained, and also that the increase of power factor should be proportional to the increase in dielectric constant. The results reported for $BaTiO_3$–$SrTiO_3$ compounds satisfy these relations approximately. It is suggested that the process of polarization of ferro-electric materials below the Curie point is similar to that of magnetization in ferro-magnetic materials.

E. RUSHTON

537.226.2

2668. The effect of purification on the ferroelectric properties of crystals of Rochelle salt. V. P. KONSTANTINOVA AND T. KH. CHORMONOV. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 1) 11–14 (1950) *In Russian.*

Measurements of the dielectric susceptibility ε and the piezoelectric modulus d_{14} of Rochelle salt were made for temperatures from 10 to 40°c. Industrial grade material showed a max. value of ε of approx. 20 000, but after purification by repeated recrystallization and by passing a current through the crystalline

salt ϵ_{max} fell to 7 000. Similarly, d_{14} fell from 260×10^{-6} e.s.u. at the Curie temperature to 40×10^{-6} e.s.u. after 4 recrystallizations and 10 days in a field of 150 V/cm. A. L. MACKAY

537.226.2

2669. The interpretation of dielectric measurements using the Cole–Cole plot. J. G. POWLES. Letter in *Proc. Phys. Soc., Lond., B*, **64**, 81–2 (*Jan.*, 1951).

See Abstr. 290 (1951).

537.226.2 : 537.311.32

2670. Electrical properties of Cu_2O. W. SAKAKI. Note in *J. Phys. Soc. Japan*, **5**, 455–6 (*Nov.–Dec.*, 1950).

537.226.2 : 548.0

2671. Dielectric dispersions of alkali halide crystals. S. KONDO AND T. SUITA. *J. Phys. Soc. Japan*, **5**, 375–8 (*Sept.–Oct.*, 1950).

KCl and NaCl and their mixed crystals cooled quickly from 600°c show one or two dielectric loss peaks with $\tan\delta$ about 2×10^{-3} at 2·6 Mc/s as the temp. is varied from 0–300°c. The exact findings depend on thermal treatment, X-ray irradiation, impurities, etc., but the activation energy, 0·08 eV (1·8 kcal), is much lower than earlier values [Abstr. 1231 (1949)]. The impurity centre responsible is not known. D. H. WHIFFEN

537.226.2 : 548.0

2672. Domain structure of tungsten trioxide. R. UEDA AND T. ICHINOKAWA. Letter in *Phys. Rev.*, **80**, 1106 (*Dec.* 15, 1950).

537.226.2 : 621.3.017.143 : 621.315.612.4

2673. Dielectric losses in ceramic dielectrics and barium titanate at high frequencies. A. L. KHODAKOV. *J. Tech. Phys., USSR*, **20**, 529–33 (*May*, 1950) *In Russian.*

Measurements were made of the loss angle of ceramic dielectrics and Ba titanate in the 10–200 Mc/s range within temperature limits of 15–180°c. H.f. measurements were made by means of a quasi-toroidal resonator. In the given wave-range $\tan\delta$ does not appreciably change for Ba titanate and falls with rising temperature. The results show that the increase of $\tan\delta$ observed by Mash may only be expected in the cm range. A decrease near the Curie point is connected with the increase of the permittivity in this region. B. F. KRAUS

537.227

2674. Phenomena of electrical saturation and pyroelectric effect in potassium phosphate, KH_2PO_4. H. BAUMGARTNER. *Helv. Phys. Acta*, **23** (*No.* 6–7) 651–97 (1950) *In German.*

The pyroelectric effect (a field of 10 000 V/cm causes an adiabatic temperature change of >1°c at a temperature of 1° above the Curie point) produces changes in the polarization caused by temperature fluctuations. These changes reduce the value of the dielectric constant. The saturation curves beyond the Curie point are contradictory to the tenets of Slater's theory and it is shown that the fundamental assumptions of this theory do not correspond to facts. The deformation remains $\propto$ the polarization also in the region of saturation. W. SUMMER

537.228.1 : 548.5 : 621.396.611.21

2675. Growing piezoelectric crystals. A. C. WALKER. *J. Franklin Inst.*, **250**, 481–525 (*Dec.*, 1950).

Work by the Bell Telephone Laboratories on the commercial production of large single crystals of ammonium dihydrogen phosphate (ADP) and ethylenediamine tartrate (EDT) is fully described. Recent progress is described in growing quartz crystals of useful size in autoclaves. H. J. H. STARKS

537.228.1 : 621.396.611.21

2676. The manufacture of quartz oscillator-plates. III. Lapping and final frequency adjustment of the blanks. W. PARRISH. *Philips Tech. Rev.*, **12**, 166–76 (*Dec.*, 1950).

For parts I and II see Abstr. 9101, 7607 (1950) respectively.

537.228.2 : 548.0

2677. The nature of electromechanical oscillations in ceramic $BaTiO_3$. N. A. ROĬ. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 5) 937–40 (1950) *In Russian.*

In an electric field the Ti atom in $BaTiO_3$ below the Curie point may move from one of 6 potential wells to another, causing a lengthening of the corresponding cell side. In an alternating field a ceramic block will oscillate at twice the applied frequency, but a steady biasing field will make this quasi-electrostriction linear. Curves are given of the variations of resonant, antiresonant and max. amplitude frequencies with biasing field, alternating field and temperature. It is found that Mason's expression for amplitude [Abstr. 570 (1949)] is valid only for low fields. For higher fields the amplitude tends towards a limit. Oscillations below the Curie point are thought to be due to quasi-electrostriction and above to pure striction. The elasticity depends on temperature and field in roughly the same way as the polarizability. A. L. MACKAY

537.228.2 : 548.0

2678. The electromechanical behavior of $BaTiO_3$ single-domain crystals. M. E. CASPARI AND W. J. MERZ. *Phys. Rev.*, **80**, 1082–9 (*Dec.* 15, 1950).

The electromechanical response of $BaTiO_3$ single-domain crystals was investigated as a function of temperature from room temperature to above the Curie point. It was found that when we eliminate domain effects, either by using a perfect single-domain crystal or by aligning the domains by an external electric field, we are dealing with a true linear piezoeffect. The linear piezoeffect was measured by both a static and a dynamic method. The values of the d_{31} piezoelectric coefficient were compared with those calculated from the dielectric constant and the spontaneous polarization. The behaviour of the piezoelectric resonance frequency was observed also through the same temperature range. Although the crystal is cubic above the Curie point and has a centre of symmetry, the piezoelectric response persisted under the application of an external d.c. field because the external field will induce a tetragonal crystal structure through the electrostrictive effect, so that the crystal becomes piezoelectric again above the Curie point. Optical and dielectric measurements were found to verify these results. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.3

2679. Electrical conductivity of borax glasses containing dispersed gold. S. K. MAJUMDAR, G. BANDYOPADHYAY AND S. DATTA. Letter in *Nature, Lond.*, **167,** 157–8 (*Jan.* 27, 1951).

537.311.31 : 539.4.016.2

2680. Anisotropy of electrical resistivity of cold-rolled cubic metals and alloys. T. BROOM. *Phil. Mag.*, **42,** 56–62 (*Jan.*, 1951).

The electrical resistivity of cold-rolled Cu, low-C steel, brass and sterling silver has been found to vary with direction of measurement. The magnitude of the anisotropy may be qualitatively accounted for by considering the effect of oriented disclocations. The temperature coefficients of resistivity of these rolled metals are isotropic to within 0·5%. These results indicate that deviations from Matthiessen's rule are to be expected. A.

537.311.32

2681. On the electrical conductivity of alumina. T. ARIZUMI AND S. TANI. *J. Phys. Soc. Japan,* **5,** 442–7 (*Nov.–Dec.*, 1950).

Conductivity was measured up to 1 500°c by the embedded probe method, and various electrode arrangements were used. The temperatures were measured by optical pyrometer and resistance thermometer, the values agreeing to ± 15°c. Samples having impurity contents up to 3·5% were examined and current creep effects were observed, the current falling by a factor of about 10 for a given applied voltage in approximately 5 minutes. These effects were greatest in specimens of lowest purity, and obeyed the law, $\log(i - i_\infty) = A - K \log t$, where time t was measured in minutes and K ranged from 0·6 to 1·6. Hysteresis effects could be observed as the polarity of the applied voltage was reversed. The results of heat treatments implied that there are two processes of conduction in Al_2O_3—an ionic and an electronic contribution. During measurements of ionic current the normally predicted pre-breakdown phenomena were observed. After severe heat treatments (when volatile impurities such as Na_2O are considered to have been removed) the activation energy for "pure" Al_2O_3 was about 2·8 to 2·9 eV and was believed to characterize electronic conduction. The effects of heating on thermionic emission using Al_2O_3 as a cathode coating are investigated and it is found that most of the applied voltage is dropped in the region between the alumina and the cathode, and the "thermionic" current obeys Schottky's law. C. A. HOGARTH

537.311.32

2682. A note on the mean free path of slow electrons in ionic crystals. S. ZIENAU. *Rep. Brit. Elect. Res. Ass., Ref. L/T*236, 5 *pp.* (1950).

The relaxation-time of slow excess electrons in ionic crystals has been calculated taking into account the 2nd-order transitions consisting of absorption of vibrational energy quanta from the lattice, followed by immediate emission of energy quanta to the lattice. Half the relaxation time given by Fröhlich and Mott [*Proc. Roy. Soc. A,* **171,** 496–504 (*July* 7, 1939)] on the basis of 1st-order time-dependent perturbation theory is obtained. P. T. LANDSBERG

537.311.32

2683. A note on the metallic behavior of $MoSi_2$. F. W. GLASER. Letter in *J. Appl. Phys.*, **22,** 103 (*Jan.*, 1951).

$MoSi_2$ prepared by direct synthesis was found to have an electric resistivity at 22°c of 21·5 microhm-cm with positive temp. coefficient.

537.311.33

2684. Diffusion of carriers of current in semiconductors with compound conductivity. V. A. LASHKAREV. *Dokl. Akad. Nauk, SSSR,* **73** (*No.* 5) 929–32 (1950) *In Russian.*

A state of thermodynamic instability occurs when the number of thermal excitations of electrons, transferring them from bound into moving state, is not equal to the number of their adherence and recombination. A case is analysed, under which only thermal excitation is present and conditions are found for which, in this case, thermodynamic stability is broken. J. LUKASZEWICZ

537.311.33

2685. Addition to my report "On electrical conduction in semi-conductors." F. STÖCKMANN. *Naturwissenschaften,* **37** (*No.* 22) 523 (1950) *In German.*

A brief indication of the wartime work of Lark–Horovitz, Seitz and Bethe, on Si and Ge crystal rectifiers, and of the recent work of Lark–Horovitz on nucleon-bombarded semi-conductors. See also Abstr. 4972 (1950). C. A. HOGARTH

537.311.33 : 621.314.64

2686. Variation of the dynamic $i(V)$ characteristic of the Al–Al_2O_3–electrolyte system as a function of frequency. W. C. VAN GEEL AND B. C. BOUMA. *Philips Res. Rep.*, **5,** 461–75 (*Dec.*, 1950) *In French.*

The current-voltage characteristic of the system Al–Al_2O_3-electrolyte is not a single curve but shows a loop. With increasing frequency the height of the loop (maximum current) decreases. The constitution of the layer is not a stable one. For rectification a particular constitution in the layer has to be created and after that the situation is still not stable, but changes with the direction of the applied voltage. It is assumed that the oxide layer contains an excess of Al in that part which is bounded by the Al. This part is semi-conducting. The other part is the barrier layer, the thickness of which changes with the direction of the applied voltage and gives rise to the loop. The thickness-variation is due to electrolysis. Another possibility is that the part of the oxide layer near the electrolyte contains a surplus of O and forms a defect semi-conductor. A.

537.311.33

2687. Changes in conductivity in germanium induced by alpha-particle bombardment. W. H. BRATTAIN AND G. L. PEARSON. *Phys. Rev.*, **80,** 846–50 (*Dec.* 1, 1950).

The bombardment of *n*-type Ge by alpha-particles from Po first removes the conducting electrons at the rate of 78 per alpha-particle. After the electrons are gone conducting holes are introduced at the initial rate of 8·6 per alpha-particle. Some of these

holes disappear with time at room temperature after bombardment is stopped, leaving only two conducting holes per alpha-particle. This change takes place only to the depth of penetration of the particles, namely $1{\cdot}9\times10^{-3}$ cm. The distribution of holes with depth is not uniform. The concentration rises from an initial value to a maximum at $1{\cdot}4\times10^{-3}$ cm depth and then falls to zero. The maximum is about 2·5 times the initial value and the integral under the curve is, of course, two holes per alpha-particle. A.

537.311.33

2688. Pressure dependence of resistance of germanium. J. H. TAYLOR. Letter in *Phys. Rev.*, **80**, 919–20 (*Dec.* 1, 1950).

In Ge the application of a hydrostatic pressure increases the width of forbidden band E_G and hence the electrical resistivity ρ at a given temperature. An analytical expression for $(\Delta\rho/\rho)$ with pressure in terms of electron and hole mobilities and concentrations is obtained in agreement with experiment, using pressures up to 4 500 lb/in², applied through silicone oil. At 300°K the pressure coefficient of resistance of Ge is found to be $= 10{\cdot}2 \pm 0{\cdot}4\times10^{-5}$ atmos.$^{-1}$. Assuming values for thermal expansion coefficient and compressibility, $\Delta E_G/\Delta T$ is found to be $= -0{\cdot}87\times10^{-4} eV/°C$. C. A. HOGARTH

537.311.33

2689. The capacitance of selenium rectifiers. R. E. BURGESS. Letter in *Proc. Phys. Soc., Lond., B*, **63**, 1036–7 (*Dec.*, 1950).

A suggestion other than anomalous dispersion is made to explain the results quoted by Cooper [Abstr. 4976 (1950)] for the variation of capacitance of Se rectifiers with frequency. A parallel is drawn between the time lag behind the applied field of the polarization and depolarization at an electrode in an electrolyte, and of the ionization and de-ionization of impurity atoms in the barrier layer of a rectifier.
C. A. HOGARTH

537.311.33

2690. Graphical determination of the Fermi level in a simple impurity semi-conductor. K. LEHOVEC AND H. KEDESDY. *J. Appl. Phys.*, **22**, 65–7 (*Jan.*, 1951).

A graphical determination of the position of the Fermi level in a simple impurity semiconductor at zero space charge is discussed. Measurements by Busch and Labhard indicate that the effective masses of electrons and holes in SiC crystals are of the order of mass of a free electron. A.

537.311.33 : 539.374

Plasticity and conductivity, analogous flow phenomena in copper alloys. *See Abstr.* 3098

537.311.33 : 548.0 : 621.314.63

2691. The impedance of crystal rectifiers with heavy d.c. loading in the direction of the barrier. E. SPENKE. *Z. Phys.*, **128** (*No.* 5) 586–604 (1950) *In German.*

The mathematical treatment is given of the diffusion theory of crystal rectifiers for high frequencies below the relaxation frequency of the low resistance interior of the semiconductor. Bardeen's hypothesis [*Bell Syst. Tech. J.*, **28**, 428 (1949)] namely, that the electron distribution in the marginal layer is independent of the pulsating a.c. load, is shown to be erroneous. W. SUMMER

537.311.35

2692. Electrical conductivity of systems consisting of melted mercury halides and ammonium halides. I. N. BELYAEV AND K. E. MIRONOV. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1217–20 (1950) *In Russian.*

It has been found that, for the melts $HgCl_2$–NH_4Cl, $HgBr_2$–NH_4Br and HgI_2–NH_4I, the isotherms of specific conductivity have more than 2 minima, and the curves of (absolute, and relative) temperature coefficients of conductivity have a corresponding number of maxima. These particular points refer to definite chemical compounds. F. LACHMAN

537.311.35.08 : 541.133.08 : 621.317.331

2693. The measurement of electrical conductivity of liquids without electrodes. F. KLUTKE. *Arch. tech. Messen, Issue No.* 176 (*Ref. V*3514–5) *T*98–*T*99 (*Sept.*, 1950) *In German.*

The current is induced in the liquid by electrostatic or electromagnetic means, and no electrode is in galvanic contact with the liquid; the process includes also the case when only one pole is coupled capacitively as with an earthed liquid. Apparatus suitable for inductive and capacitive methods and the associated measurement circuits are described. Important advantages are that the measurements may be made with the liquid totally enclosed and also contact effects are avoided. A. M. THOMAS (R)

537.312.5

2694. Experimental investigations of oxygen-caesium films. P. G. BORZYAK. *J. Tech. Phys., USSR*, **20**, 928–36 (*Aug.*, 1950) *In Russian.*

Optical and photoelectric character of oxygen-caesium films was investigated in connection with problem of 3-component photocathodes Ag–O–Cs, and compared with 2-component films Cs–O. The method was that of the optical and photoelectrical wedge which had answered well in many similar investigations. There is an essential difference in the characteristics of extended photocathodes of Sb–Cs and, on the other hand, Cs–O and Ag–Cs–O cathodes. The spectral characteristics of the external photo-effect of Sb–Cs correspond to those of optical absorption and the spectral maximum of the photosensitivity is determined by the maximum of optical absorption. From the fact that the quantum output reaches values the order of which nears unity it follows that the absorption in this case is of a photoelectric nature. Between the spectral characteristics of the photo-effect and of optical absorption of Cs–O and of Ag–O–Cs photo-cathodes there is no similarity whatsoever. The quantic output of a real Ag–O–Cs photocathode, even at the sensitivity maximum, is usually less than 1%. It follows that the basic optical absorption determined by the optical constants in these cases is not of a photoelectric character. On it is superimposed the considerably less intense photo-electric absorption, indirectly inferred from the photo-effect. Consequently, the concentration of the photoelectrically absorbing centres, probably of an admixture character, is small, whilst for Sb–Cs photo-

cathodes the photoelectric absorption at the spectral maximum is the characteristic absorption of the basic material of the film. B. F. KRAUS

537.312.5 : 535.215

2695. The second order photoelectric effect at a metal surface. R. E. B. MAKINSON AND M. J. BUCKINGHAM. *Proc. Phys. Soc., Lond., A*, **64**, 135–9 (*Feb.*, 1951).

An expression is derived for the photoelectric current excited at the surface of a metal by radiation of frequency below the threshold frequency of the first-order photoelectric effect. A physical interpretation of the formal results is given and the possibility of detecting this current experimentally is briefly discussed. A.

537.312.5 : 535.215.4 : 621.383 : 621.316.8

2696. The application of light-sensitive resistors. P. GÖRLICH. *Z. Naturforsch.*, **5a**, 563–8 (*Oct.*, 1950) *In German.*

PbS, PbSe, PbTe layers have been produced that are light-sensitive up to 6 μ. In the luminous spectral range, CdS and CdSe light-sensitive resistors show a long-wave limit of 0·9 and 1·1 μ, whereas CdTe has its limit at 1·2 μ. The maxima are at 0·520, 0·740 and 0·850 μ, respectively. The frequency response is much better than with Se-cells. Better still are Michelssen's mesh cells of galena which show a response independent of frequency up to 40 kc/s. These cells have successfully been used for scanning i.r. television pictures at 100 lines and 25 pictures/sec. It is suggested that the quality of modern light-sensitive resistors is such that the possibilities of their application, except to precision photometry, are unrestricted. W. SUMMER

537.312.5 : 537.311.33

2697. Characteristics of selenium photocells. P. T. LANDSBERG. Letter in *Proc. Phys. Soc., Lond., B*, **64**, 82–3 (*Jan.*, 1951).

The results of Preston [Abstr. 7997 (1950)] agree well with Landsberg's theoretical relation [Abstr. 2453 (1950)].

537.312.62

2698. Remarks on the 'nucleus' theory of superconductivity. K. M. KOCH. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 309–12. *In German.*

See also Abstr. 281 (1950).

537.312.62

2699. Measurement of the surface resistance of superconducting tin at 9 380 Mc/s. M. S. KHAĬKIN. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 661–4 (1950) *In Russian.*

Two methods of measurement of the Q of a superconducting tin resonator are described. In one the resonance curve is displayed on a c.r.t. and in the other the decay of resonant oscillations is observed. The temperature variation of resistance agrees with that found by Fairbank [Abstr. 1760 (1950)]. See also Pippard [Abstr. 8755 (1950)]. D. SHOENBERG

537.312.62

2700. Mass dependence of the superconducting transition temperature of mercury. B. SERIN, C. A. REYNOLDS AND L. B. NESBITT. Letter in *Phys. Rev.*, **80**, 761 (*Nov.*, 1950).

It is pointed out that the transition temperature of a superconductor depends not only on its isotopic constitution but also on its physical state which for Hg depends sensitively on the method of cooling. Experiments in which 4 isotopes of Hg were cooled in similar conditions showed that T_c varied as $M^{-\frac{1}{2}}$ rather than $M^{-0\cdot378}$ as suggested by Herzfeld, Maxwell and Scott [Abstr. 323 (1951)]. See also Abstr. 6509 (1950). D. SHOENBERG

537.312.62

2701. An empirical correlation among superconductors. J. G. DAUNT. Letter in *Phys. Rev.*, **80**, 911–12 (*Dec.* 1, 1950).

It is pointed out that if the electronic specific heat per unit volume per °K of the known superconductors in the normal state is plotted against transition temperature, the points fall roughly on two straight lines corresponding to the "hard" and "soft" groups. D. SHOENBERG

537.312.62

2702. Superconductivity of niobium. L. C. JACKSON AND H. PRESTON-THOMAS. Letter in *Phil. Mag.*, **41**, 1284–7 (*Dec.*, 1950).

Measurements on the critical magnetic field and transition temperature of Ni show that these are very sensitive to the state of the material, and the detailed results obtained depend on the methods of measurement. The results may be interpreted if it is supposed that the material is not completely homogeneous. See also Abstr. 8003 (1950). D. SHOENBERG

537.312.62

2703. Two new superconducting elements. B. B. GOODMAN. Letter in *Nature, Lond.*, **167**, 111 (*Jan.* 20, 1951).

Os and Ru are found to be superconductors with transition temperatures of 0·71 and 0·47°K respectively. The critical fields of these and a number of other elements satisfy the relation $H_c = H_0(1 - (T/T_c)^2)$. H_0 is 65 gauss for Os and 46 gauss for Ru. These values are similar to those given for other elements with low transition temperatures. D. SHOENBERG

537.312.62

2704. Theory of the superconducting state: II. Magnetic properties at the absolute zero of temperature. H. FRÖHLICH. *Proc. Phys. Soc., Lond. A*, **64**, 129–34 (*Feb.*, 1951).

For Pt I see Abstr. 325 (1951). The London equations are now derived in the sense conjectured by F. London. A.

537.312.62 : 536.2

2705. Anomalous heat flow in superconductors. K. MENDELSSOHN AND J. L. OLSEN. *Phys. Rev.*, **80**, 859–62 (*Dec.* 1, 1950).

Measurements of heat flow in the superconductive and in the normal state have been carried out on pure Pb and Pb containing a small quantity of Bi. The heat conduction has been measured in its dependence on magnetic field and temperature. The alloy shows a smaller heat conduction in the intermediate state

than in either the superconductive or the normal state. This anomalous behaviour is taken to indicate the existence in superconductors of a type of heat transport similar to that observed in liquid Heii. A.

537.312.62 : 538.24

2706. Magnetic moments and eddy currents in spheres of superconducting tin. J. J. Fritz, O. D. Gonzalez and H. L. Johnston. *Phys. Rev.*, **80**, 894–9 (*Dec.* 1, 1950).

Experiments have been carried out to measure the "frozen in" moments through demagnetization from fields sufficient to destroy their superconductivity. Moments were determined with a torsion pendulum made from the spheres. Both solid Sn spheres and spheres filled with non-superconducting material were examined. Small permanent moments, fixed in magnitude and direction, and probably associated with traces of impurity, were observed for the solid spheres while considerably larger fixed moments were observed for the hollow spheres. The observed permanent moments, which amounted to 1 to 3% of the induced moments calculated for the critical field depended to a slight extent on the magnitude of the fields used to produce them and were also dependent on the size and geometry of the spheres and on the temperature. Entry into the intermediate state was evidenced by a sudden gain in the total magnetic moment when the measuring field attained a value which was close to 2/3 of the critical field, H_c. This effect is interpreted as due to the formation of regions of normal metal in the intermediate state as also are the permanent moments. The results can be explained in terms of Landau's theory of the intermediate state that postulates the presence of threads or plates of normal metal. A.

537.312.62 : 538.63

2707. Landau diamagnetism and Meissner effect. A. Papapetrou. *Phil. Mag.*, **42**, 95–105 (*Jan.*, 1951).

It is shown that, if in a superconductor the distribution of the electrons in momentum space differs a little from the spherical one, an internal field of the second type will be formed inside the superconductor; the Meissner effect then follows for not too strong external fields.

537.362 : 621.359.2 : 631.4

2708. Notes on an application of the electro-osmotic process to consolidating clay soils. L. Zaretti. *Energia Elett.*, **27**, 625–31 (*Oct.*, 1950) *In Italian.*

Previous attempts at draining and drying clay soils by electric current showed that energy consumption was too high for large-scale application and the effect was only temporary. Laboratory experiments showed that the use of Al electrodes caused a permanent change in consistency of the soil. As the Sarca-Molvero Hydro-electric Co. encountered difficulties in the building of a tunnel conduit through a stratum of clay, laboratory experiments were undertaken to study electro-osmotic drying and electrolytic structure changes. Apparatus and method are described and results are discussed. Subsequent field tests are described. The soil lost all characteristics of clay and became an excellent foundation ground. The energy consumption in the process was reduced to 11·5 kWh per m² of surface. J. A. Wilcken

ELECTRIC DISCHARGES 537.52

537.521 : 535.33

2709. On the spectral method of investigating statistical phenomena in a gaseous discharge. S. I. Borovitskiĭ and E. I. Tikhonova. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 449–52 (1950) *In Russian.*

Describes a new simple experimental method based on the investigation of the spectrum of the current produced in the discharge tube when its electrodes are fed with a periodic (e.g. sinusoidal) voltage. The spectrum is composed of (1) discrete lines, (2) continuous spectrum, the latter being due to statistical phenomena. F. Lachman

537.521.7

2710. Recent research on spark discharges in gases. J. D. Craggs and J. M. Meek. *Research, Lond.*, **4**, 4–10 (*Jan.*, 1951).

Reviews (*a*) spark breakdown of gaps subjected to unidirectional d.c. and impulse voltages, (*b*) breakdown at high frequencies. 50 refs. A.

537.523

2711. Electric wind from a point electrode. V. I. Arabadzhi. *J. Tech. Phys., USSR*, **20**, 967–9 (*Aug.*, 1950) *In Russian.*

A qualitative picture of the circulation of electric wind of the space charge around the point and measurements in a certain speed range. The speed field was mapped out for a point at a potential of 5 kV by exposures of 30 sec duration. Isolines were taken for 0·1 and 0·12 m/sec speeds. An inductor of 35 cm maximum sparking distance was used. B. F. Kraus

537.523

2712. Investigation of the initial stage of the discharge for very small inter-electrode distances. I. S. Stekolnikov. *Izv. Akad. Nauk, SSSR, Otdel. Tekn. Nauk* (*No.* 7) 985–94 (1950) *In Russian.*

The investigation of the character of the discharge in air or oil showed that if conditions favouring bridge formation obtain (contamination of the electrode surfaces bounding the gap in air or a liquid medium by products of pyrolysis and erosion) the inception of the discharge may be brought about by conducting filaments or "bridges." With a reduction of the voltage across the electrode-gap, or an equivalent mutual approach of the electrode surfaces, the probability of bridge formation grows, and at voltages below 200–300 V the discharge does not begin with a breakdown of the gas, but has the character of a fusion or blow-out of the conducting bridge. The discharge starts here with an electric contact. The time required for bridge formation does not exceed $(5–10)\times10^{-8}$ sec, and within this time the resistance falls to 2–3 ohm or less; this explains the failure to discover the bridges of former investigators working with c.r.o.'s at comparatively low sweep rates. The practical interest of this special problem is in electric erosion tools. B. F. Kraus

537.523.3/.4 : 537.525.3/.4

2713. Considerations of reaction and the similarity principle in the initiation of gaseous electrical discharges. W. Fucks. *Arch. Elektrotech.*, **40** (*No.* 1) 16–30 (1950) *In German.*

Discusses, in terms of the similarity principle, the

theories of breakdown put forward by Townsend, Royowski, Loeb and others. Exptl. results are considered in some detail. J. D. CRAGGS

537.523.4

2714. Influence of barriers on the development of the electric discharge in long gaps. V. S. KOMELKOV AND A. M. LIFSHITS. *Izv. Akad. Nauk, SSSR, Otdel. Tekh. Nauk* (*No.* 10) 1463–74 (1950) *In Russian.*

Investigation of retarded impulse discharges in long gaps of the types point-plane and point-point with a barrier inserted showed that space charges accumulating on the barrier and in the ionization zone change the trajectory of the discharge, reinforce its stepped character and draw out its period of development. A barrier placed between positive point and plane inhibits flashover and produces incomplete discharge of characteristic form: streamers reach the barrier without penetrating it; leaders have a stepped character, and do not reach the barrier, but travel in different directions 2–3 cm above it; branches of leaders may attain lengths 2 to 3 times the distance between point and barrier. Discharge is incomplete owing to space charge set up by streamers and distorting original field, the direction of the maximum gradients no longer coinciding with the shortest distance between the electrodes. Possibility of flashover is determined by processes between point and barrier, not between barrier and plane. Breakdown takes place if the leader penetrates the barrier. The influence of the barrier results then in retardation of discharge and increase of its stepped character. The development period is thus prolonged. The curves of duration of discharge *v.* position of barrier are similar to those obtained by other workers for breakdown voltages *v.* barrier position. In a negative point-plane discharge the barrier produces considerable increase of stepped character and of duration of discharge. In a point-point gap a discharge similar to that between a point of the corresponding polarity and a plane develops from each of the points.

B. F. KRAUS

537.523.4

2715. Voltage gradients in high current spark channels. J. E. ALLEN. Letter in *Research, Lond.*, **3,** 527–8 (*Nov.*, 1950).

Describes measurements of the total spark gap voltage, for various gap lengths, in air discharges carrying currents of up to 265 kiloamps. Expts. were made with Mg, Cu/W and W electrodes and the total (anode + cathode) electrode voltage drops may be determined from the results. J. D. CRAGGS

537.523.4

2716. Formative time lags of spark breakdown in air in uniform fields at low overvoltages. L. H. FISHER AND B. BEDERSON. *Phys. Rev.*, **81,** 109–14 (*Jan.* 1, 1951).

Formative time lags were measured in a uniform field for overvoltages of a few per cent down to as close to threshold as possible. Such measurements have been carried out as a function of pressure (atmospheric to a few cm of Hg) and plate separation (0·3 to 1·4 cm). For pressures greater than 200 mm Hg, the formative time lags very close to threshold are of the order of 100 μsec and longer. These times are orders of magnitude longer than those previously reported. For all pressures studied, the time lags decrease as the per cent overvoltage increases, until at about 2% above threshold, the formative times are of the order of 1 μsec. The time lag *v.* per cent o.v. curve is independent of pressure from atmospheric down to 200 mm Hg. At a given per cent o.v., the time lags increase linearly with plate separation. Changing the approach voltage from 2 to 4 kV below breakdown does not affect the results appreciably. The number of initiating electrons at the cathode has been varied by a factor of about 7, and this again does not materially alter the results. The long time lags and their dependence on pressure and per cent o.v. cannot be explained by secondary emission of electrons from the cathode by positive ion bombardment. The proper explanation is the enhancement of field-intensified ionization due to field distortion acting in conjunction with a photoelectric secondary process. The experiment demands an extension of the streamer concept of breakdown, and makes very questionable the role of positive ion bombardment of the cathode in spark breakdown for the pressures and plate separations studied. No transition region for change of streamer to Townsend breakdown was found. A.

537.523.5 : 536.55

2717. A new method of temperature measurement in high pressure arc columns. II. H. BARTELS. *Z. Phys.*, **128** (*No.* 4) 546–74 (1950) *In German.*

A detailed theoretical paper dealing with extensions of the method described in part I [Abstr. 6518 (1950)] in which measurements of discharge temperatures are made from observations of the emitted spectral-line profiles in cases where self-absorption is appreciable. The method is applied to practical measurements made by Koch, Lesemann and Walther [Abstr. 6523 (1950)]. J. D. CRAGGS

537.525

2718. Suppression of high frequencies in the production of Joshi effect. M. V. RAMANAMURTI AND S. SHAMIN AHMAD. Letter in *Curr. Sci.*, **19,** 309–10 (*Oct.*, 1950).

537.525.6 : 538.56

2719. Radioelectric emission due to the gyromagnetic effect in a discharge. M. LAFFINEUR AND C. PECKER. *C.R. Acad. Sci., Paris,* **231,** 1446–7 (*Dec.* 18, 1950) *In French.*

A line of frequency $eH/2\pi mc$ was detected, which is best observed at a pressure of 10^{-4} mm Hg. At this pressure the collision width is 3 Mc/s. It is not certain whether the observed line is due to direct gyromagnetic radiation, or to forced plasma oscillations with the gyromagnetic frequency. L. PINCHERLE

537.525.8

2720. Corrections of the work by D. Kamke on the mechanism of the canal-ray discharge. D. KAMKE. *Z. Phys.*, **128** (*No.* 4) 493 (1950) *In German.*

Refers to the earlier paper [Abstr. 348 (1951)] by the same author in which a differential equation (p. 227, *loc. cit.*) was given incorrectly, and gives the necessary corrections. J. D. CRAGGS

537.528 : 621.3.015.51 : 621.315.615

2721. The mechanism of electrical puncture of liquid dielectrics with suspended metals. L. G. GINDIN, L. M. MOROZ, I. N. PUTILOVA, YA. I. FRENKEL. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 49–52 (1950) *In Russian.*

A theoretical explanation is given of phenomena previously described [see Abstr. 8769 (1950)].

J. LUKASZEWICZ

X-RAYS 537.531

537.531

2722. Summarized proceedings of conference on high-intensity X-ray beams—London, April 1950. A. E. DEBARR AND I. MACARTHUR. *Brit. J. Appl. Phys.*, **1**, 305–18 (*Dec.*, 1950).

Report of the annual spring conference of the X-ray Analysis Group of The Institute of Physics. In addition to the evening discourse by A. Guinier on "The production and application of high-intensity X-ray beams" there were papers on the following subjects: "The development of the high-powered moving-anode X-ray tube" (A. Taylor); "The modified 50-kW X-ray generator at the Davy Faraday Laboratory" (D. P. Riley); "A high-intensity X-ray generator" (J. S. Thorp); "A survey of recent work in Holland" (J. S. Woldringh); "A micro-focus X-ray tube" (R. Witty and P. Wood); "A fine-focus X-ray tube" (W. Ehrenberg and W. E. Spear); "Some factors in precision monochromatization and collimation" (I. MacArthur); "The production of converging beams by total reflexion" (W. Ehrenberg); "A parallel beam concentrating monochromator" (P. Gray); "The application of high-intensity X-ray beams in biological and colloid chemistry" (D. P. Riley); "Measurement of diffuse scattering and scattering by hydrogen atoms" (P. G. Owston); "A micro-beam technique applied to the study of cold-worked metals" (P. B. Hirsch); "Temperature-variation of structures in homologous series" (I. MacArthur); "Study of the abrasion of crystals" (P. Gray). Shorter contributions and discussions are also summarized. 84 refs.

537.531 : 53.081.6

A new evaluation of h/e by X-rays. *See Abstr.* 2357

537.531 : 535.43 : 532.7

2723. The small-angle scattering of X-rays by nitrogen. R. L. WILD. *J. Chem. Phys.*, **18**, 1627–32 (*Dec.*, 1950).

An experimental study has been made of the scattering of X-rays by N at various pressures and temperatures in the general region of the critical point. Particular attention was given to the scattering at small angles. Cu Kα-radiation used with a single-crystal spectrometer and narrow slits provided the means of attaining low values of $\sin\theta/\lambda$ where 2θ is the scattering-angle and λ the wavelength of radiation. A qualitative demonstration of the effect of pressure and temperature upon the small-angle scattering from a fixed volume of sample was made. At 29 selected conditions of pressure and temperature, more complete patterns were taken in an attempt to obtain values of the isothermal compressibility and the sizes of regions of inhomogeneity which give rise to the small-angle scattering. Values of compressibility from this work are roughly comparable to those obtained by other methods. The regions of inhomogeneity are found to be small at low temperatures, and they increase in size as the P–T conditions approach the critical region. Typical values for their radii are found to be 3·8 Å at 115°K and 18·7 atmos., and 8·1 Å at 128°K and 36·8 atmos. A.

537.531 : 548.733 : 621.386.1

2724. Linked X-ray tubes for the research laboratory. R. JACQUESSON. *J. Phys. Radium*, **11**, 639–40 (*Nov.*, 1950) *In French.*

An arrangement of three demountable X-ray tubes for structure work is described, in which the transformer and the vacuum is common to all tubes, but in which the currents can be controlled separately. Each tube can be shut off and dismantled without affecting the others. W. F. BERG

537.531 : 615.849

2725. Dosage units for high-energy radiation. U. FANO AND L. S. TAYLOR. *Radiology*, **55**, 743–7 (*Nov.*, 1950).

The present definition of the roentgen unit is not satisfactory for high-energy radiations. At the Radiology Congress, 1950, tentative definitions have been so formulated that future developments will be covered and only the practical application will have to be reformulated as new cases arise. It has been suggested that all results be expressed in standard physical units, namely e.s.u. of ionization per gram material. W. SUMMER

537.531.08 : 614.898.5 : 778.334

2726. A new method of use of the photographic film as quality indicator and dose meter for X- and gamma rays. G. SPIEGLER. *Photogr. J.*, **90B**, 166–71 (*Nov.–Dec.*, 1950).

A new photographic method for the determination of the quality of X- and gamma-radiations is described. Use is made of the variation of the electronic emission from metal foils with wavelength. The intensifying factor under a Sn foil used as a front screen serves as an indicator of the quality, an electron-stopping filter across a Pb foil at the back of the film permitting discrimination between high energy quanta and the region of soft X-rays. The method permits determination of the quality of the radiation scattered outside the primary beam and outside the irradiated object. Applications of the method and protection problems are discussed. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

2727. Ejection of the electron beam from a betatron. S. L. FAWCETT AND E. C. CRITTENDEN, JR. Note in *Rev. Sci. Instrum.*, **21**, 935–6 (*Nov.*, 1950).

The method utilizes the perturbing magnetic field produced by a current pulse flowing in a pair of conductors, placed above and below the orbital plane. The conductors are segments of circles concentric with the axis of the machine, extending over an azimuth of 40° at the outer edge of the normal

region of electron stability. The two conductors are externally connected in series and carry current in the same direction. A rectangular current pulse, variable up to 500 amp., 20 μsec wide, is applied to the ejector conductors a few microseconds before the expansion coils are pulsed.

537.533.7

2728. On the energy loss of fast electrons in thin layers. O. Blunck and S. Leisegang. *Z. Phys.*, **128** (*No.* 4) 500–5 (1950) *In German.*

Landau's theory [Abstr. 23 (1947)] for the probability distribution of the energy loss of fast electrons in thin layers is carried through to a higher degree of approximation, and hence leads to a greater numerical half-width for the distribution curve. This modification improves agreement with the experiments by White and Millington [*Proc. Roy. Soc.*, **120**, 701–26 (*Oct.* 1, 1928)] and by Paul and Reich [Abstr. 6533 (1950)]. P. T. LANDSBERG

537.533.7

2729. On range-momentum measurements for electrons in gases. G. F. O'Neill and W. T. Scott. Letter in *Phys. Rev.*, **80**, 473 (*Nov.* 1, 1950).

The range-curvature relation, in a field of 4 000 gauss, for Compton electrons of momentum up to 1·1 MeV/c was examined in H_2 and He at 136 atmospheres in a cloud chamber with water-alcohol condensant. Scattering was shown to be insignificant, and the treatment of large transfers of energy discussed. The first tracks measured showed good agreement with theory. J. G. WILSON

537.533.7 : 621.38

2730. Congruent space charge flow. G. B. Walker. *Proc. Phys. Soc., Lond., B*, **63**, 1017–27 (*Dec.*, 1950).

The paper is mainly concerned with one type of congruent flow, namely irrotational flow, and propositions are established regarding (*a*) rectilinear motion, (*b*) motion in which the current density is constant along lines of flow, and (*c*) the representation of lines of flow by the level lines of a harmonic function. From the latter, three corollaries are deduced regarding flow in which the space charge density is constant either throughout the motion, or along lines of flow or along lines of constant action. Two cases of curvilinear flow, originating from a unipotential cathode, are discussed and are shown to possess important features regarding magnification and transit time. A.

537.533.72

2731. On the significance of the concepts "focal point" and "focal distance" in electron optics, and on strong electron lenses with Newtonian image equations. W. Glaser and O. Bergmann. *Z. angew. Math. Phys.*, **1** (*No.* 6) 363–79 (1950) *In German.*

The idea of focal distance in the case of electron lenses is examined, and it is pointed out that the usual definition does not in general specify the formation of the image in dealing with strong electron lenses. The relations between the positions of object and image are more complicated than those of light optics. These relations are investigated mathematically and the conditions under which the ordinary optical equations are valid are discussed. The second part of the paper is devoted to the study of strong fields and the circumstances in which the term focal distance retains physical significance. The experimental determination of focal distances is briefly examined. M. R. HOPKINS

537.533.72

2732. Calculation of optical constants of magnetic electron lenses from pole-piece dimensions and operating conditions. F. Lenz. *Z. angew. Phys.*, **2** (*No.* 11) 448–53 (1950) *In German.*

Gives the results of the calculation of such quantities as focal-length, depth of focus, spherical and chromatic aberration, under various conditions. The results on focal length are compared with measurements reported in the literature and the differences discussed. J. THEWLIS

537.533.72

2733. Spherical aberration of a double focusing beta ray spectrometer. N. F. Verster. Letter in *Physica*, **16**, 815–16 (*Oct.*, 1950).

537.533.72

2734. Beta-ray spectrographs with electron lenses. (Unified theory of classical types: a new apparatus.) I. P. Grivet. *J. Phys. Radium*, **11**, 582–95 (*Nov.*, 1950) *In French.*

Gives an optical theory for a simple design of β-ray spectrograph, which is also applicable to the various types in current use. All the principal optical properties of the system are considered. J. THEWLIS

537.533.72

2735. A condenser aperture device for electron microscopes. J. D. Boadway. Letter in *J. Appl. Phys.*, **22**, 104–5 (*Jan.*, 1951).

A device is described for holding and aligning a thin Pt diaphragm, contamination being avoided by the heating of the electron bombardment. The reduction of spherical aberration by the use of a small aperture is demonstrated.

537.533.72 : 539.165.08

2736. Theory of the double lens β-spectrometer. W. Bothe. *S.B. Heidelberg. Akad. Wiss.* (*Math.-Naturwiss. Kl.*) (*No.* 3) 13 *pp.* (1950) *In German.*

Longer version of previous paper [Abstr. 6539 (1950)]. As in Slätis and Siegbahn's spectrometer [Abstr. 7068 (1949) and 3185 (1950)] an intermediate ring focus is formed, but here it is midway between 2 similar lenses, assumed thin even for rays steeply inclined to the axis [see Abstr. 365 (1951)]. Deviation is expressed as a power series in aperture, referred to the "principal" ray which is symmetrically refracted by the 2 lenses. Aberration is expressed by a quadratic term. Resolution depends on the annular slit at the intermediate image, whose size is calculated as a function of the geometry (including the annular lens aperture) and of the power and primary aberration coefficient of the lenses. The effect of finite source size is considered. J. C. E. JENNINGS

537.533.72 : 539.165.08

2737. An electrostatic beta-spectrograph. D. R. Hamilton and L. Gross. *Rev. Sci. Instrum.*, **21**, 912–17 (*Nov.*, 1950).

A beta-ray spectrograph has been constructed in which electrons move radially outward against a retarding electric field, and the current due to those

electrons having more than any given energy is measured. Momentum resolution is $\frac{1}{3}\%$. The insensitivity of current collection, as compared to single particle detection, is compensated by a large tolerable source area and a large useful solid angle subtended at the source by the detector. A.

537.533.72 : 539.165.08

2738. Further studies—experimental and theoretical—of a wide-angle β-spectrometer which uses a prolate spheroidal magnetic field. T. H. BRAID AND H. O. W. RICHARDSON. *Proc. Phys. Soc., Lond., A*, **64**, 163–74 (*Feb.*, 1951).

See Abstr. 1937 (1949). A β-spectrometer is described which focuses a conical sheaf of rays emitted at about 80° to the axis of a prolate spheroidal magnetic field. In agreement with theoretical prediction, the trajectories cross over at two sites in the rotating meridional plane. The field behaves in some ways like a magnetic mirror and can be arranged to form an aberration-free image of a point on the axis of symmetry. It cannot, however, give a clear image of an area because the Abbe sine condition is not fulfilled. The wide-angle focusing action is compared with that recently found by Slätis and Siegbahn, for which a different optical analogue is suggested, based on the isolation of a meridional focal line between two refractions. The adjustment of the spectrometer and measurements of its resolving power and solid angle of collection are described, an example being $1{\cdot}4\%$ of 4π with a line-width of $\frac{1}{113}$ at half-height. By working at less than unit magnification it is possible to focus rays emitted at less than 80° to the axis. A.

537.533.72 : 621.385.833

2739. Direction double focusing of electron beams in inhomogeneous electromagnetic fields. W. GLASER. *Öst. Ingen. Arch.*, **4** (*No.* 5) 354–62 (1950) *In German.*

Focusing by electron beams, the main beam of which is a circle situated symmetrically to the axis of an axially-symmetrical electromagnetic field, is investigated. The focusing is in general an astigmatic one. The conditions for the variation of the field in the immediate neighbourhood of the main beam, to get an anastigmatic image formation, are described. The possibilities for application of the device in velocity- and mass-spectroscopy are indicated. A.

537.533.72 : 621.385.833

2740. A new "quotient meter" for the electron microscope. R. STRAUSS. *Arch. Elektrotech.*, **40** (*No.* 1) 49–56 (1950) *In German.*

Describes a method for obtaining maximum image sharpness in a magnetic electron microscope, which is based on the measurement of the ratio of the accelerating voltage to the square of the lens current. An electron tube, set up in parallel to the electron microscope, is used. It embodies a cold cathode and the control of image sharpness is automatic. J. THEWLIS

537.533.72 : 621.385.833

2741. Calculation of the aberrations of electrostatic lenses by the method of calculating electron trajectories. P. P. KASYANKOV. *J. Tech. Phys., USSR*, **20**, 483–8 (*April*, 1950) *In Russian.*

Differential equations convenient for practical work are given for the calculation of the sagittal and orbital foci of an infinitely thin beam (pencil). Some hints are also given aiming at the simplification of the calculating work when determining electron trajectories. In one of the examples the higher orders of spherical aberration are evaluated and a correction is introduced for the mean curvature of the image.

B. F. KRAUS

537.533.72 : 621.385.833

2742. The detection and direct measurement of the axial astigmatism [astigmatisme d'ellipticité] of an electron lens. R. CASTAING. *C.R. Acad. Sci., Paris*, **231**, 894–6 (*Oct.* 30, 1950) *In French.*

Measurements on an e.s. lens have confirmed the theory given in Abstr. 929 (1951). The object was a metallized Perspex ["plexiglass"] thread $\sim 0{\cdot}1\ \mu$ dia. Measurements of the distorted line observed give the astigmatic constant in terms of the spherical aberration. Correction of axial astigmatism by Bertein's method [*C.R. Acad. Sci., Paris*, **225**, 801–3 (1947)] could be detected with fair exactitude. J. C. E. JENNINGS

537.533.72 : 621.385.833

2743. An objective for use in the electron microscopy of ultra-thin sections. J. HILLIER. *J. Appl. Phys.*, **22**, 135–7 (*Feb.*, 1951).

An objective has been designed which is particularly suitable for the study of tissue sections. It consists of a large opening polepiece system operated at a focal length of 12 mm. It includes a diaphragm which can be centred (not during operation) and translated on the axis. Angular apertures of 2×10^{-3} radian with large areas of bright field can be achieved. A simple method of aligning the aperture is described. A.

537.533.73

2744. Methods of interpreting electron diffraction diagrams. H. BILDÉ. *Ann. Radioélectricité*, **5**, 354–90 (*Oct.*, 1950) *In French.*

A general survey of the principles and practice of electron diffraction, with illustrations of its applications to various problems. Includes a discussion of transmission and reflection methods and the study of single crystals, polycrystalline material and gases.

J. THEWLIS

537.533.73

2745. Experimental study of an electron gun for electron diffraction. P. RENAUD. *J. Phys. Radium*, **11**, 619–21 (*Nov.*, 1950) *In French.*

A method is described for the production of a very narrow beam of electrons for diffraction, for which no limiting aperture is necessary. A current of as little as 1 μA (as against about $0{\cdot}5$ mA in conventional apparatus) may be employed, with high stability. A hot filament is used, but high stability may also be achieved with a cold cathode. J. THEWLIS

537.533.73 : 621.385

2746. Electron diffraction in valve technology. H. A. STAHL. *Schweiz. Arch. angew. Wiss. Tech.*, **16**, 359–69 (*Dec.*, 1950) *In German.*

The applications of electron diffraction in surface problems such as electron emission and getter action are discussed. The experimental technique is described along with some specialized equipment for this type of problem. Many examples of diffraction patterns are shown, and a bibliography of 33 items is included. A. H. W. BECK (R)

537.533.74

2747. On the depolarization of electrons by multiple scattering and reflection-transmission effect. N. RYU. *J. Phys. Soc. Japan*, **5**, 423–8 (*Nov.–Dec.*, 1950).

In some experiments on the polarization of electrons, there is a discrepancy between their results and the theory. The effect of multiple scattering, as a depolarization factor, cannot explain the discrepancy as is shown by Rose and Bethe. As another cause of the discrepancy, the plural scattering, which is the combination of two rather large angle deflections in the same foil, is considered in some detail. Such a plural scattering gives rise to values of the so-called "reflection-transmission" effect agreeing with experimental results. It is shown that the negative experimental results obtained by Dymond, Thomson, and Richter can be accounted for, if this effect is taken into account. A.

537.533.74/.75 : 539.165

2748. Transmission of beta-rays by nylon and formvar. R. B. HELLER, E. F. STURCKEN AND A. H. WEBER. *Rev. Sci. Instrum.*, **21**, 898–902 (*Nov.*, 1950).

The per cent beta-ray transmission by thin nylon and formvar films (windows) was studied to obtain experimental "absorption" corrections to be used with G–M counters employing such thin windows. "Absorption" included energy loss and scattering. The results are plotted in several ways to exhibit the various factors involved and to permit easy use in applying the corrections. It was found that scattering was a factor of considerable importance, whereas energy lost was not very important for the range investigated (< 32 keV). The electron energy range investigated was limited to the region in which the "absorption" correction was considerable for the window thicknesses used. A scintillation counter was used as the detector, and the source of monoenergetic electrons was an electron gun with electrostatic focusing. A.

537.533.8

2749. Secondary electron emission of aluminium oxide. A. R. SHULMAN AND I. YU. ROZENTSVEĬG. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 497–500 (1950) *In Russian.*

In Al_2O_3 σ changes with time under impulse conditions, the rate of change depending upon the field polarity in the layer of the dielectric. Observed independence of σ from temperature shows the interaction of secondary electrons with electrons of the conducting zone of the dielectric is not important with Al_2O_3 even under temperatures under which observable thermionic emission exists.

J. LUKASZEWICZ

537.533.8

2750. Some characteristics of the secondary electron emission from potassium chloride films. V. N. FAVORKIN. *J. Tech. Phys., USSR*, **20**, 916–22 (*Aug.*, 1950) *In Russian.*

The secondary electron emission of KCl films depends essentially on the thickness of the films. For thicknesses $< 0{\cdot}15\,\mu$ the emission depends mainly on the influence of the support of the film. For $0{\cdot}15$–$0{\cdot}2\,\mu$ the emission from KCl is widely independent of the primary current. For thicknesses $> 0{\cdot}2\,\mu$, σ depends on the primary current, determined by the potential gradient in the film and the auto-electron emission of the support. This is due to an insufficient depth effect of the excitation of conductivity in the film by the primary beam; the thicker the film the more the ratio 2° current/1° current rises with increasing primary current. The secondary current, determined by auto-electron emission, and its ratio to primary current, depend on a series of factors, particularly on excitation conditions (of primary current), preliminary electron bombardment of film, film structure and its evaporation conditions. At a certain primary current intensity, secondary current becomes unstable. KCl films disintegrate comparatively rapidly and irreversibly under influence of primary current; secondary current falls during sustained irradiation. The disintegration is due to electrolysis of the KCl in an electric field and thus affects all thicknesses of films. All properties found prove that despite the high true secondary-emission coefficient and comparatively high amplification factor in the auto-electron emission a practical use of KCl films as secondary-electron emitters is impossible.

B. F. KRAUS

537.533.8 : 548.0

2751. Equilibrium currents induced in zincblende by electron bombardment of negative electrode. M. F. DISTAD. *Phys. Rev.*, **80**, 879–86 (*Dec.* 1, 1950).

The current induced in zincblende crystals when the negative electrode is bombarded by 5 to 900 V electrons has been measured. The electrodes were evaporated Cu films 0·02 or 0·05 micron thick. The experimentally observed ratio of the equilibrium bombardment-induced crystal current to the bombarding current (*a*) had values ranging from about 10^{-5} to 10^{-9}, (*b*) was independent of the magnitude of the bombarding current, (*c*) was proportional to the bombarding voltage raised to the nth power where n ranged from 2·0 to 2·6 for bombarding voltages up to 600 V, (*d*) did not show a dependence on the crystal temperature, and (*e*) increased as the potential difference between the crystal electrodes was increased. A space charge in the crystal, apparently very near the bombarded electrode, had a major effect on the time variation of the bombardment-induced current and on the magnitude of its equilibrium value. The primary result of bombardment seems to be the emission of electrons into the crystal from the electrode. It does not appear to be necessary to assume that internal secondaries were a major source of conduction electrons. A.

537.533.8 : 621.385.15

2752. Secondary emission cathodes. B. D. TAZULAKOV. *J. Tech. Phys., USSR*, **20** (*No.* 7) 773–87 (1950) *In Russian.*

A method of thermal dosage of the active material on the emitter surface for industrial purposes, for replacing Asao and Suzuki's procedure (*Proc. Phys.-Math. Soc. Japan*, **12**, 247 (1930)] which aims at higher conductivity in the intermediate layer. The principle of method consists in the use of a loosened-up surface with the active materials adsorbed on it.

B. F. KRAUS

537.533.8 : 621.385.15

2753. Measurement of secondary emission from insulators. R. Barthélemy. *C.R. Acad. Sci., Paris*, **232**, 20–2 (*Jan.* 3, 1951) *In French.*

The insulating screen is bombarded by pulses of electrons and the current build up in the signal plate lead is viewed by an oscilloscope. If $f(v)$ is the velocity distribution function, then $\int_0^v f(v)dv = (\delta - 1)i_b - i_s$, where i_b = beam current, i_s = signal plate current, δ = secondary emission coeff. The measurement gives i_s as a function of time, δ can be deduced from $\delta = \frac{i_s(0)}{i_b} + 1$, and the voltage between screen and signal plate is $u = \frac{1}{C}\int_0^t i_s dt$. These relations allow one to deduce $f(v)$ which is found to be of the form $f(v) = a_v \cdot e^{-bv^2}$. The max. of the distribution occurred for 1·2–1·6 eV for the materials studied.

A. H. W. Beck (R)

537.533.8 : 621.385.15

2754. Secondary emission of nickel-barium mixtures and rhenium when bombarded by electrons with energies from 50 to 8 000 electron-volts. H. E. Farnsworth and M. J. Lun. *J. Appl. Phys.*, **22**, 77–9 (*Jan.*, 1951).

The experimental tube contains a contamination-free gun which directs an electron beam at normal incidence on to a small thin sheet target which may be heated by conduction. The target is located at the centre of a conducting sphere to permit a measure of the secondary current, and also of the energy distribution of the secondary electrons by means of the retarding potential method. The maximum value of δ, the secondary emission ratio, for a cast alloy of Ni containing 1·5% Ba is 2·8 and occurs at 800 to 900 V after a critical amount of previous heat treatment of target. The value of δ_{max} increases with heat treatment of target, subsequent to baking of tube, to the above value and then decreases with further heating. For the critical condition the value of δ above 4 000 V is sensitive to the amount of previous electron bombardment of the target. A δ_{max} of 1·3 for Re after thorough out-gassing was obtained at 900 V. The most probable energy of low speed secondary electrons from Re is approximately 5 eV. A.

537.533.8 : 621.385.15

2755. A pulse method of determining the energy distribution of secondary electrons from insulators. K. G. McKay. *J. Appl. Phys.*, **22**, 89–94 (*Jan.*, 1951).

A novel method is described of determining the energy distribution of emitted secondaries from an insulator. This is based on an analysis of the transient resulting from pulse bombardment. The analysis is simplest when leakage through the target is negligible, but the effect of leakage is also treated. Space charge limitation of the emitted current is assumed to be negligible. A.

537.534 : 621.384.6

2756. Synchrotron-oscillation resonance. N. M. Blachman. *Rev. Sci. Instrum.*, **21**, 908–11 (*Nov.*, 1950).

The frequency of phase oscillation in a synchrotron is so low as to make possible resonances with harmonics of the power-supply frequency. The interaction may take place through ripple in the magnetic field or in the frequency or amplitude of the accelerating voltage, the first two interacting very strongly and the third moderately. Thus, a small ripple in the magnet power supply output, though it produces only an extremely small ripple in the magnetic field because of the magnet's inductance, may tend to cause large phase oscillations. The detuning effect of the fall in phase oscillation on frequency with increasing amplitude limits the resulting amplitude, however, and may even reduce the amplitudes of initially large phase oscillations. The ripple in the accelerating field is unlikely to be sufficient at a resonant frequency to cause trouble. In addition to ripple, there will be noise which, particularly through modulation of the frequency of the accelerating field, may result in time in considerable phase oscillations because the noise contains a wide range of frequencies, one of which is always in resonance throughout the acceleration cycle. A.

537.534.72

2757. On the suppression of the exit slit in an ion source. F. Bertein. *C.R. Acad. Sci., Paris*, **231**, 1134–6 (*Nov.* 20, 1950) *In French.*

Since the intermediate slit in an ion source of the Nier type can act as a lens, producing an image of the true source at the exit slit, the latter may be removed or replaced by a larger slit if it is already larger than the image referred to. The conditions under which this can occur are examined. J. Thewlis

537.534.74

2758. Collision cross sections of hydrogen and of deuterium. I. Amdur, M. C. Kells and D. E. Davenport. *J. Chem. Phys.*, **18**, 1676–8 (*Dec.*, 1950).

Total collision cross-sections have been measured for H atoms, with energies between 300 and 800 eV, scattered in room temperature H, and for D atoms, with energies between 500 and 1 150 eV, scattered in room temperature D. The H–H_2 cross-section has a pronounced maximum at 600 volts indicating the presence of inelastic scattering. In the case of D–D_2 there is a similar effect, less pronounced, at about 800 volts. Classical theory has been used to evaluate the repulsive potentials for the two systems on the assumption that smooth curves through the experimental results represent elastic cross-sections, and that the atoms and molecules are mass points whose interaction forces are spherically symmetrical. The D–D_2 potential is considerably larger than that for H–H_2 for r between 0·29 and 0·56 Å, but the difference decreases markedly as r increases. It is suggested that the apparent difference in the potentials may result from the assumption of spherical symmetry which, even on a relative basis, does not exist in the present case because of the difference in the nuclear statistics of H_2 and D_2. A.

537.534.74

2759. Deuteron-proton scattering at 10.0 Mev by a coincidence method. H. J. Karr, R. O. Bondelid and K. B. Mather. *Phys. Rev.*, **81**, 37–48 (*Jan.* 1, 1951).

A description is given of a scattering chamber possessing several novel features. This chamber was

applied to the determination of absolute cross-sections for elastic scattering of 10·0 MeV deuterons by protons, over a range of angles from 45° to 160° in the centre-of-mass system. Two independently movable proportional counters were connected in coincidence and set at appropriate angles with respect to the incident beam so that coincidences were recorded between deuterons entering one counter and their recoil protons entering the other. The advantages and disadvantages of this system are made clear. The scattering media were thin nylon and polyethylene-terephthalate foils. The relative cross-sections reported are believed to be accurate to $\pm 3{\cdot}5\%$ and the absolute values to $\pm 5\%$. Some comparison is made with the *mhbw* theory of Buckingham and Massey. Agreement is excellent over a considerable range of angles; but the theoretical curve is shallower than the experimental, and considerable anomaly appears at large angles. The experimental curve rises very steeply beyond about 120° in the centre-of-mass system. A.

537.534.74

2760. The importance of gas scattering in particle accelerators. L. Riddiford. *Proc. Phys. Soc., Lond., A*, **64**, 10–12 (*Jan.*, 1951).

In electron and proton synchrotrons there exists a minimum useful vertical aperture of the vacuum chamber, and for apertures less than this the beam intensity falls to zero. It is considered, on the basis of a comparison of theory and experiment, that this phenomenon is in the main due to free oscillations which arise from gas scattering. The final beam size in proton synchrotrons may be substantial for this reason also, but for cyclotrons the large spread which is known to exist must be attributed to some other phenomenon. A.

537.534.79

2761. Theory of the polarization of canal rays. I. Elementary processes. G. Ecker. *Z. Phys.*, **128** (*No.* 4) 511–29 (1950) *In German.*

Four elementary processes can be defined as the origin of the polarization phenomenon. The results are expressed with the aid of matrices and tabulated functions. The polarization phenomena are immediately explicable by, and can be calculated from these results. W. SUMMER

DISCHARGE TUBES . COUNTERS 537.54

537.542

2762. "Giant" pulses in vapour filled counters. E. Fünfer and H. Neuert. *Z. Phys.*, **128** (*No.* 4) 530–7 (1950) *In German.*

Continuation of Abstr. 8808 (1950). The discharges producing the "giant" pulses appear to be limited to the region of the primary (α-particle) ionization. An explanation is suggested on the basis of the theory of Loeb and Meek [*J. Appl. Phys.*, **11**, 438, 459 (1940)]. A. O. STANESBY

537.542

2763. Temperature effect in Geiger–Müller counters. M. Kimura. Letter in *Phys. Rev.*, **80**, 761–2 (*Nov.* 15, 1950).

537.542

2764. A note on the geometry of Geiger counter telescopes. H. E. Newell, Jr. and E. C. Pressly. *Rev. Sci. Instrum.*, **21**, 918–22 (*Nov.*, 1950).

The contribution of a portion of the solid angle of a two-counter telescope to the total coincidence rate is studied for both isotropic and (cosine)^2 law radiation fields. Formulas and graphs are presented for estimating the percentage of counts due to radiation from directions near the telescope axis. The average path length traversed by particles passing through the telescope is touched upon briefly. A.

537.542

2765. A Geiger-counter mounting for continuous counting of gas-phase radioactivity. F. Bonner and A. Weinstein. Note in *Rev. Sci. Instrum.*, **21**, 934–5 (*Nov.*, 1950).

537.542

2766. Erratum: The scintillation efficiency of anthracene for low energy electrons. W. J. Ramler and M. S. Freedman. *Rev. Sci. Instrum.*, **21**, 922 (*Nov.*, 1950). See Abstr. 1127 (1951).

537.542 : 539.166

2767. A coincidence scintillation spectrometer. B. Aler and O. Björklund. *Ark. Fys.*, **2**, *Paper* 39, 427–30 (1950).

537.542

2768. The properties of spark counters of the Rosenblum type. R. D. Connor. *Proc. Phys. Soc., Lond., B*, **64**, 30–44 (*Jan.*, 1951).

The design and operation of Rosenblum-type spark counters having plane, concave and convex cathodes is described, and discussed with reference to the counting characteristics, useful life and background counting rate. The absolute efficiency of the counter in air has been determined for α-particles, knock-on protons, and β-particles, giving values of about 90%, 5% and 0·0002%, respectively. A marked dependence of efficiency on specific ionization and air pressure is evident. The counter is directional in all its forms. The effect of employing gases other than air is also investigated and a qualitative description of the counting characteristics is given. Alpha-particle ranges may be determined using either a single counter or two counters used in anticoincidence as is described in the text. A.

537.542 : 621.318.572

2769. Current integrators for counter tubes. K. H. Lauterjung. *Z. angew. Phys.*, **2** (*No.* 11) 433–7 (1950) *In German.*

The thyratron- and the multivibrator-driven pulse integrators, and the advantages of the latter type (time-saving method of establishing the calibration; very small percentage deviation from linearity) are discussed in detail and a c.r.t. method given for quickly arriving at an exact calibration. W. SUMMER

537.542 : 621.318.572

2770. A magnetic scaling circuit. H. Hertz. Letter in *J. Appl. Phys.*, **22**, 107 (*Jan.*, 1951).

537.542 : 621.385.5 : 621.318.572

2771. The use of a frequency-modulation detector as a coincidence circuit. H. Piatier and R. Génin. *C.R. Acad. Sci. Paris*, **231**, 1055–7 (*Nov.* 13, 1950) *In French.* For abstract see Abstr. 947 B (1951).

537.542 : 621.396.615.17

2772. Input multivibrator of high resolving power for coincidences. P. COLOMBINO. *Nuovo Cim.*, **7**, 955–60 (*Nov.* 20, 1950) *In Italian.*

A six-channel coincidence circuit with a resolving power of <1 μsec has been studied and used in researches on penetrating showers. Each channel has a cathode-coupled input multivibrator unit for counter quenching. One of the two tubes of this unit also acts as a cathode follower and gives a low impedance output. Each multivibrator unit is coupled directly to the G.M. counters so that input parasitic capacitance is reduced to a minimum and thus an improved transmission of h.f. components of the pulse is obtained. A.

537.542 : 621.317.761 : 621.3.018.75

2773. A single channel pulse analyser for nuclear experiments. J. S. EPPSTEIN. *J. Sci. Instrum.*, **28**, 41–4 (*Feb.*, 1951).

The instrument described was designed to measure the frequency-pulse size distribution from nuclear detectors. It accepts all pulses whose height falls between two voltage levels; the mean value of these levels is variable over a range of 5 to 40 V, while the difference between them remains constant at one of two pre-determined voltages. A.

537.543 : 621.385.2

2774. Erratum: Theory of the parallel plane diode. A. H. TAUB AND N. WAX. *J. Appl. Phys.*, **22**, 108 (*Jan.*, 1951). See Abstr. 399 (1951).

IONIZATION . THERMIONICS 537.56/.58

537.581 : 621.385.032.21

2775. Certain refractory compounds as thermionic emitters. D. L. GOLDWATER AND R. E. HADDAD. *J. Appl. Phys.*, **22**, 70–3 (*Jan.*, 1951).

Several refractories of the nitride, boride and carbide families are investigated as sources of thermionic electrons. An activation pattern qualitatively common to several of the compounds is observed. Emission data for the final state of activation are presented. Data concurrently obtained for thoria are also given for comparison. True temperature used in the Richardson equation is obtained by correction from brightness temperature. Temperature correction curves have been obtained. These curves can be satisfactorily represented in the region of thermionic emission by one value of spectral emissivity, which values are listed for the materials studied. A.

537.583

2776. Periodic deviations in the Schottky effect for tantalum. R. J. MUNICK, W. B. LABERGE AND E. A. COOMES. *Phys. Rev.*, **80**, 887–91 (*Dec.* 1, 1950).

Periodic deviations from the Schottky law in the thermionic emission from patchy surfaces of Ta and Th on Ta have been measured for fields up to 3×10^5 V cm^{-1}, and at temperatures of 1 200 and 1 500°K. The work function of the clean Ta as determined by Richardson plots was $4{\cdot}03 \pm 0{\cdot}04$ eV, and was changed by approximately 1/2 volt by Th deposition. A method was found for separating the periodic deviations from the patch effects. For clean Ta the phase and amplitude of the deviations are in approximate agreement with the theory when the tunnel effect is neglected. The temperature variation was found to be in accordance with theory. The Th on Ta caused the amplitudes of the deviations to decrease and the phase to shift towards lower fields. The decrease of amplitude seems to rule out the existence of a potential peak at a composite emitter surface of this type. A.

537.583 : 535.235

Spectral emittance of Ni and oxide coated Ni cathodes. *See Abstr.* 2492

537.583 : 621.385.5 : 621.385.032.216

2777. The leaky-condenser oxide cathode interface. A. EISENSTEIN. *J. Appl. Phys.*, **22**, 138–48 (*Feb.*, 1951).

The time-dependence of current passed by commercial pentodes has been studied under pulsed conditions of operation. A decay of current is observed in the microsecond time range for those tubes operated for long periods under cut-off conditions. This decay has been interpreted in terms of the resistance and capacitance of the interface layer known to exist from X-ray diffraction studies. Techniques are developed and applied to the measurement of this interface resistance and capacitance as a function of temperature. Following the initial current decay, a partial recovery is observed when long pulses are used. This effect results from Joule heating of the interface layer. A.

537.583 : 621.385.032.216

2778. Deterioration of oxide-coated cathodes under low duty-factor operation. J. F. WAYMOUTH, JR. *J. Appl. Phys.*, **22**, 80–6 (*Jan.*, 1951).

The behaviour of oxide cathodes coated on a Ni alloy containing about 0·1% Si has been investigated under 100% and zero duty-factor operation. The operation of these cathodes at zero duty factor was found to be highly favourable to the development of a high resistance in a layer of Ba_2SiO_4 located at the interface between the oxide and the core. The layer itself was present not only in cathodes that had aged without electron emission and had developed interface resistance, but also in cathodes that had aged with electron emission and had not developed interface resistance. A model is presented to account for the experimental observations. Evidence is also presented which shows that an "active" Ni alloy that does not lead to undue interface resistance formation may exist. A.

COSMIC RAYS 537.591

537.591.1

2779. Calculation of the moments of distribution function of shower particles. S. Z. BELENKII. Transl. in *Guide Russ. Period. Lit. Brookhaven*, **3** (*No.* 10) 281–7 (*Oct.*, 1950).

Full translation of article abstracted in Abstr. 2536 (1950).

537.591.1

2780. On the origin of cosmic rays. E. BAGGE. *Z. angew. Phys.*, **2** (*No.* 11) 462–72 (1950) *In German.*

Reviews experimental evidence concerning properties of the primary radiation, and summarizes various theories advanced for its origin.

E. P. GEORGE

537.591.1

2781. Abundance of lithium, beryllium, boron, and other light nuclei in the primary cosmic radiation and the problem of cosmic-ray origin. H. L. BRADT AND B. PETERS. *Phys. Rev.*, **80**, 943–53 (*Dec.* 15, 1950).

A combination of sensitive and insensitive photographic emulsions is used to improve the accuracy of measurement of the specific energy loss of relativistic nuclei. The method is applied to the determination of the charge spectrum of the primary cosmic radiation at geomagnetic latitude $\lambda = 30°$ and results in nearly complete resolution between neighbouring elements up to $Z \sim 14$. It is shown that Li, Be and B nuclei are almost or entirely absent in the primary cosmic ray beam. Since nuclear disintegrations of energetic heavy ions frequently lead to fragments of $3 \leqslant Z \leqslant 5$ it is concluded that most heavy primary nuclei do not suffer nuclear collisions between the time of acceleration and arrival and that this time must be less than $10^6/\rho$ years, where ρ is the density of atoms along the trajectory. This result seems to be in disagreement with several recent theories on the origin of cosmic rays and raises some general difficulties for theories assuming galactic origin. A.

537.591.1

2782. The ionization of cosmic-ray particles. P. GOODMAN, K. P. NICHOLSON AND H. D. RATHGEBER. Letter in *Proc. Phys. Soc. Lond.*, *A*, **64**, 96–7 (*Jan.*, 1951).

A proportional counter filled to 86 cm Hg with A + 6% ethylene was used in conjunction with a magnetic deflection spectrograph to examine the ionization of cosmic-ray particles as a function of momentum in the range $2{\cdot}4\times10^8 < p < 4\times10^{10}$ eV/c. The results, combined with cloud-chamber drop counts for mesons, and compared with cloud-chamber drop counts for electrons, are considered to indicate, that while the ionization of electrons is well described by the Halpern–Hall modification of the Bloch relation, that of μ-mesons is not adequately given, being experimentally considerably too low at high momentum. J. G. WILSON

537.591.1

2783. Energy degeneration of cosmic-ray primaries. F. J. MILFORD AND L. L. FOLDY. *Phys. Rev.*, **81**, 13–19 (*Jan.* 1, 1951).

Under the assumptions that a meson-producing collision between two nucleons with relativistic energies is completely inelastic and that the collision cross-section is independent of energy, one can calculate the energy degeneration of the primary cosmic rays (assumed to be nucleons) and the energy spectrum of high-energy nucleons as a function of depth in the atmosphere for any primary spectrum. While this model is highly restricted, it is of considerable interest for comparison with experimental results, since it leads to the maximum possible rate of energy degeneration for nucleons. Binding of nucleons into nuclei is neglected (except for the "packing effect" on the mean-free-path for collision) and the results are further limited to energies greater than 1 BeV where energy loss due to ionization is negligible and the velocity of the nucleons may be taken to be the velocity of light. Analytic solutions are obtained for the energy spectrum at any depth for monoenergetic and power-law primary spectra. The effect of the geomagnetic cut-off on a primary power-law spectrum is also investigated. A.

537.591.15

2784. Structure of anomalously large atmospheric showers of cosmic radiation. D. V. SKOBELTSYN AND H. T. ZATSEPIN. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1157–60 (1950) *In Russian.*

Contradicts the suggestion that the authors' observations on extensive showers of 1 km extent may be understood in terms of normal cascade showers. More recent measurements are discussed and it is concluded again that these super-extensive events are examples of a new type of shower.

E. P. GEORGE

537.591.15

2785. Observations of atmospheric showers of cosmic radiation of more than 1 000 m width. G. T. ZATSEPIN, I. L. ROZENTAL, V. P. ZAKHAROVA, N. G. KHREBET AND G. B. KHRISTIANSEN. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 29–32 (1950) *In Russian.*

Master pulses, derived from 4-fold coincidences in 2 pairs of trays placed 1 000 km apart operated a hodoscope in which the discharges in further counter trays were analysed. Each of the main counter trays was of area 1 m² approx., and situated at 3 860 m altitude. The 4-fold rate (corrected for accidentals) was 1·7 per hr, and the 6-fold 0·4 per hr.

E. P. GEORGE

537.591.15

2786. Study of wide showers of cosmic particles at sea level. L. KH. EĬDUS, N. M. BLINOVA, V. G. VIDENSKIĬ AND L. D. SUVOROV. *Dokl. Akad Nauk, SSSR*, **74** (*No.* 3) 477–80 (1950) *In Russian.*

4-fold coincidences, C_4, studied between 2 pairs of counter trays at separations, D, up to 400 m. For $2 < D < 100$ m, C_4 seems to be determined by cascade theory, but for $D > 100$ m definitely not so. For these large values of D, values of C_4 at sea level and 3 860 m are very much the same. Suggests that atmospheric showers consist of central electron-photon cascade, with periphery consisting of penetrating particles (μ-mesons?), causing anomalously high frequency of coincidences at large values of D.

E. P. GEORGE

537.591.15

2787. The instability of particles generating electron-nuclear showers. M. I. PODGORETSKIĬ, A. L. LYUBIMOV, M. N. SHCHERBAKOVA AND L.KH. EĬDUS. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 1) 15–17 (1950) *In Russian.*

Showers under thick Pb absorbers were studied. The non-equivalence of further C or air absorbers is taken to indicate that the particles causing some events are unstable. The possible effect of π-mesons is discussed. E. P. GEORGE

537.591.15

2788. Narrow air showers of cosmic rays. III. Further absorption measurements. J. N. P. Wei and C. G. Montgomery. Letter in *Phys. Rev.*, **80**, 480 (*Nov.* 1, 1950).

Previous absorption measurements at altitude and sea level had not agreed, but the counter systems were different. On repeating the sea-level measurements with a similar counter set to that used at altitude, similar results are obtained. E. P. GEORGE

537.591.15

2789. Penetrating showers in carbon. J. R. Green. *Phys. Rev.*, **80**, 832–41 (*Dec.* 1, 1950).

The penetrating showers generated in C by the cosmic radiation have been investigated by means of a cloud chamber containing both C and Pb plates which was operated at an elevation of 12 000 ft. It is shown that the penetrating showers generated in C are closely the same in angular distribution and in average multiplicity of penetrating particles as the penetrating showers produced in Pb, comparison values in Pb being obtained from previous work with the same cloud chamber containing only Pb plates. Penetrating showers produced in the C plates were followed not infrequently by production of secondary penetrating showers farther down in the C; the initiating particles of the subsequent showers are very closely aligned with the direction of the primary particles of the parent penetrating shower. The mean free path of the lightly ionizing secondary particles of the penetrating showers for subsequent production of nuclear events was found to be 237 ± 29 g/cm² C. The mean free path of the penetrating particles for large-angle scattering in the C is about 4 times this value. The electronic cascades produced at the same time as the penetrating component are satisfactorily explained in order of magnitude by assuming that they are produced by high-energy gamma-rays which originate at the event or which may be derived from the fast decay of neutral mesons very near the original event. A.

537.591.15

2790. The nature of wide-angle sprays. I. R. R. Rau. Letter in *Phys. Rev.*, **80**, 914 (*Dec.* 1, 1950).

Wide-angle sprays of ionizing particles, emerging from Pb plates into which either one or no ionizing particle enters, have been studied using a random-operated cloud chamber containing ½ in Pb plates and also thin Pb foils at 16 g/cm² residual pressure in 55° N latitude. Sprays, defined as of $\geqslant 6$ minimum ionizing particles of angular spread $> 30°$, are shown to consist predominantly of electrons, and to be mainly electron-photon cascades. The occurrence of events associated with a cascade axis making a small angle with the horizontal is thought to contribute significantly to the apparent large multiplication in thin (~ 2 cascade units) transition layers.

J. G. WILSON

537.591.15

2791. The nature of wide-angle sprays. II. R. R. Rau and A. S. Wightman. Letter in *Phys. Rev.*, **80**, 914–15 (*Dec.* 1, 1950).

See previous Abstr. The flux of cascade producing electrons and photons necessary to produce the observed numbers of wide-angle sprays in the plates of the cloud chamber is shown to be in rough agreement with that deduced to arise from the decay of π^0 mesons from nuclear collisions. J. G. WILSON

537.591.15

2792. Penetrating showers of cosmic rays. A. G. Voisin. Letter in *Phys. Rev.*, **80**, 920 (*Dec.* 1, 1950).

A counter array enclosed in Pb and located under a 35 cm Pb shield consists of a fivefold selecting shower array, a horizontal array of individually recorded counters from which the lateral spread of penetrating showers is estimated, 2 further counter trays used to indicate the range of the showers, and a discriminating, unshielded tray which indicates the association of recorded events with extensive showers. Results show that, for penetrating showers not associated with the discharge of the discriminating tray, the penetration of showers increases with increasing lateral spread. J. G. WILSON

537.591.15

2793. Improved calculations on cascade shower theory. I. B. Bernstein. *Phys. Rev.*, **80**, 995–1005 (*Dec.* 15, 1950).

The diffusion equations of cascade shower theory are solved by means of a perturbation method. The first approximation is taken to be that solution obtained by Snyder using the so-called completely screened cross-sections for the elementary processes of bremsstrahlung and pair production. The correction to this is then calculated using more refined approximations to the Bethe–Heitler cross-sections. The results, which lend themselves to accurate numerical work only in the case of light elements and high incident energies, indicate with respect to Snyder's solution that (1) the shower maximum is decreased in height and slightly shifted to greater depths, (2) there is a decrease in the average number of electrons present at small absorber depths and a correspondingly larger number at large depths. The magnitude of the correction is larger than had been previously assumed. Numerical results are given so that the correction to the solution under the assumption of completely screened cross-sections can be readily calculated for all light elements when the incident particle is either a single photon or a single electron. A.

537.591.15

2794. Cascade theory including ionization loss. L. Jánossy and H. Messel. *Proc. Phys. Soc., Lond., A*, **64**, 1–4 (*Jan.*, 1951).

The Bhabha–Chakrabarty solution of the cascade equations with ionization loss [Abstr. 1087 (1949)] is discussed, and a simplified method of numerical evaluation suggested. A.

537.591.15

2795. The existence of a secondary maximum in the transition curve of electron-photon showers. R. Maze and Tsai-Chü. *C.R. Acad. Sci., Paris*, **232**, 224–6 (*Jan.* 15, 1951) *In French.*

Two crossed layers of counters placed 65 cm below a Pb transition layer 75×75 cm² area are particularly sensitive to pairs of particles originating in the transition material with angular separation about 4°. A statistically significant secondary maximum is detected for a transition thickness 6 cm Pb: this

maximum is eliminated when 6 mm Al is placed over the counter trays or 4 mm Pb is placed between them.
J. G. WILSON

537.591.15 : 539.172

2796. The nuclear interaction length of the particles in penetrating cosmic-ray showers. K. H. BARKER AND C. C. BUTLER. *Proc. Phys. Soc., Lond., A*, **64**, 4–9 (*Jan.*, 1951).

The work of Rochester and Butler [Abstr. 3820 (1948), 1088 (1949)] and that of Butler, Rosser and Barker [Abstr. 3236 (1950)] has been continued. In particular, the interaction properties and the spectrum of the penetrating particles are considered. The interaction length of the shower particles with momenta greater than 10^9 eV/c is found to be 18 cm lead ($\pm$ 20%). A.

537.591.5

2797. Some time variations of cosmic rays. A. R. HOGG. *J. Atmos. Terr. Phys.*, **1** (*No.* 2) 114–20 (1950).

Cosmic-ray observations made at Canberra have been examined for variations according to sidereal time and compared with an analysis of results from other localities. The analysis was made by noting annual changes in the phase and amplitude of the first harmonic of the apparent solar diurnal variation. A regular change of phase with a period of one year may be caused by a true sidereal diurnal variation. Such regular changes have been found in the results for several stations. However, these changes do not occur simultaneously over the globe. The changes differ in phase by about 180° in the northern and southern hemispheres with a tropical station having an intermediate position. This suggests that the variations are not sidereal but are of a solar-seasonal nature. Changes in the amplitude of the solar diurnal variation display no obvious world-wide regularity in the results examined. A.

537.591.5

2798. On an indirect influence of solar activity on the intensity of cosmic rays. E. G. v. ROKA. *Z. Naturforsch.*, **5a**, 517–30 (*Oct.*, 1950) *In German.*

Suggests that the 27-day cosmic-ray period may be due to heating of the upper atmosphere by u.v. radiation, the latter being known to show a similar period. Experimental evidence for a 11-yr period is reviewed, and an analogous explanation advanced.
E. P. GEORGE

537.591.5 : 550.381

2799. Theoretical geomagnetic effects in cosmic radiation. R. A. ALPHER. *J. Geophys. Res.*, **55**, 437–71 (*Dec.*, 1950).

A brief review is given of the theory of the effect of the earth's magnetic field on cosmic radiation. The basic results of the theory are presented in graphical form, and are intended to be useful in the experimental investigation of cosmic radiation. The material presented includes curves of minimum energy of arrival, as measured in Störmer units, *v.* azimuth angle, for zenith angles at 10° intervals, arising from the combined Störmer and shadow cone (for all latitudes at 10° intervals), and from the main cone (at latitudes 0°, 20° and 30°). Minimum momentum in BeV/c, and minimum energy in BeV, for protons and heavy nuclei, are given *v.* geomagnetic latitude for azimuths N, S, E and W, at all zenith angles in 15° steps. Other available presentations of the basic theory are mentioned and the conversion procedures involved in the application of the theory are described. A.

537.591.8

2800. Some transmutations of the elements caused in the atmosphere by cosmic rays. C. E. ANDERSEN. *Nat. Verd., Copenhagen*, **34** (*No.* 5–6) 149–64 (1950) *In Danish.*

A popular exposition of present ideas concerning the characteristics of isotopes, elementary particles and radioactive transmutations. Reasons for the "invention" of the neutrino and antineutrino are given, and some data on isotope percentages in He, N and C, and life-times, are included. Characteristics of cosmic rays are described, the ratios of numbers of nuclei H : He : (C+N+O) : heavier elements are stated as 4 000 : 1 000 : 35 : 10, and the results of collisions with atomic nuclei in the atmosphere are discussed. Secondary rays, formation of radioactive H and C, and characteristics of mesons (π and μ) are described. It is suggested that the formation of C^{14} by N^{14} meson capture may be of quantitative significance, though subordinate to the $N^{14}(n, p)C^{14}$ process. J. A. WILCKEN

537.591.8

2801. Effects of cosmic rays shown in pictures. C. E. ANDERSEN. *Nat. Verd., Copenhagen*, **34** (*No.* 5–6) 165–82 (1950) *In Danish.*

A number of reproductions of Wilson-chamber and photographic recordings of meson, α-particle and cosmic-ray explosion tracks (published elsewhere) with detailed explanations of the interpretations.

J. A. WILCKEN

537.591.8

2802. Coincidental impulses in ionization chambers. S. I. NIKOLSKIĬ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 695–8 (1950).

Four cylindrical ion chambers at the 4 corners of a square were placed under C and Al absorbers. Observations of various coincidences enabled separation of shower and star contributions to bursts at 3 860 m. E. P. GEORGE

537.591.8

2803. Emission of Li_3^8 nuclei in cosmic ray stars. E. PICKUP AND L. VOYVODIC. *Canad. J. Res. A*, **28**, 616–27 (*Nov.*, 1950).

One of the more interesting features of cosmic-ray stars is that Li^8 nuclei are ejected occasionally in the nuclear disintegrations. Such nuclei are characterized by the fact that, at the end of their range, they suffer radioactive decay ($\tau = 0{\cdot}9$ sec) into Be^8, which immediately splits up into 2 oppositely directed α-particles, giving what is usually referred to as a hammer track. In this investigation numerous examples have been observed of the emission of such nuclei in stars in photographic emulsions, the stars having from 2 to 60 prongs. In particular, it has been shown that the energy spectrum of the α-particles forming the hammer tracks is in good agreement with that observed by other workers, and also with experiments made, using the cloud chamber technique, indicating that the Be^8 in this disintegration is formed

in the excited state. When an electron-sensitive emulsion is used it is shown that the hammer track is accompanied by the Li^8 disintegration electron. The energy spectrum of the Li^8 nuclei is plotted, and the mechanism of the formation is discussed for both large and small stars. A.

537.591.8

2804. Nuclear disintegrations at 29 000 meters above sea level. M. M. Addario and S. Tamburino. Letter in *Phys. Rev.*, **80**, 749–50 (*Nov.* 15, 1950).

Disintegration stars in Ilford C2 emulsion exposed at 14 g cm^{-2} residual atmosphere in 55° N geomagnetic latitude showed (i) a ratio of 0·6 of particles $Z \geqslant 2$ to protons for all star sizes, (ii) that for all sizes of star, practically all α-particles are of energy less than the potential barrier of the heavy nuclei, and (iii) some evidence for the association of stars. Results (i) are in general agreement with the α/p ratios of Harding, Lattimore and Perkins, (ii) differs from observations at mountain altitude: it is suggested that in primary stars nuclear fragments are frequently emitted which break up subsequently into α-particles of relatively low energy. J. G. WILSON

537.591.8

2805. Cascade processes recorded in an emulsion chamber exposed in the stratosphere. H. Yagoda. Letter in *Phys. Rev.*, **80**, 753–4 (*Nov.* 15, 1950).

Observations are described on a pile of 5 unbacked emulsion disks, of thickness 1 200–2 400 μ, exposed at 90 000 ft for 6·8 hr in 55° N geomagnetic latitude. Two notable stars are discussed. In one of these a star probably initiated by an A nucleus emits a fragment, probably Ne, which follows the direction of the primary for 8·9 mm before breaking further to yield 6 fast charged particles in a narrow cone, without associated slow nucleons. J. G. WILSON

537.591.8

2806. Cloud chamber observations on the electromagnetic component from nuclear explosions and the development of the nuclear cascade. A. Lovati, A. Mura, G. Salvini and G. Tagliaferri. *Nuovo Cim.*, **7**, 943–53 (*Nov.* 20, 1950).

The results of a research on nuclear explosions, made at the Laboratorio della Testa Grigia (3 500 m) with a counter-controlled cloud chamber are reported. Principal aim of the research is to study the electromagnetic component arising from nuclear explosions and the development of the nuclear cascade. A.

537.591.8

2807. The interpretation of coincidences between counters encased within a block of lead: showers of penetrating particles incident from the air or local effects originating in the lead. A. Fréon. *J. Phys. Radium*, **11**, 691–6 (*Dec.*, 1950) *In French.*

Observations with various arrangements of counters, placed in individual cavities in a block of Pb, lead to the conclusions (i) coincidences between three counters, not in alignment, separated by up to 5 cm Pb are mainly due to electrons secondary to single mesons; (ii) coincidences between non-aligned counters at separations of the order 20 cm are about 85% due to local nuclear explosion and at most 15% due to penetrating showers incident from the air. J. G. WILSON

537.591.8

2808. Local penetrating events underground. R. Maze. *C.R. Acad. Sci., Paris*, **231**, 1295–7 (*Dec.* 6, 1950) *In French.*

The response of an array of 8 counters embedded in Pb, each counter directly surrounded on all sides by 5 cm Pb, is compared at sea-level and under 30 m earth. The counters are individually recorded, and certain combinations cannot be operated either by the direct trajectories of mesons or by the accompanying soft component arising in elastic collisions. The underground frequency of such combinations is in accord with the existence of a nuclear component secondary to the μ-meson beam. An abnormal number of horizontal, penetrating trajectories underground is similarly attributed to secondary nucleons and mesons. J. G. WILSON

537.591.8

2809. Some rare phenomena in photographic emulsions exposed to cosmic rays. L. Gillon, F. Gillain and A. Melin. *Ann. Soc. Sci. Brux.*, **64**, *Ser.* 1, 196–200 (*Dec.* 13, 1950) *In French.*

537.591.8

2810. Evidence for the multiple production of mesons in a single nucleon-nucleon collision. J. J. Lord, J. Fainberg and M. Schein. *Phys. Rev.*, **80**, 970–3 (*Dec.* 15, 1950).

The event was observed in a photographic emulsion exposed to the cosmic radiation at an altitude of 95 000 ft. The nuclear encounter in which the mesons were created was produced by a primary proton of 3×10^{13} eV energy. Directly in line with the incident proton 7 particles of minimum ionization were emitted in a central core with an angular divergence of 0·003 radian. In addition 8 other minimum ionization particles were emitted in a wider diffuse cone of 0·13 radian angular divergence. Only one track had the appearance of a fragment which, however, could have been a proton of 10 MeV energy. Most of the particles in the central core had energies in excess of 250 BeV, while those in the diffuse cone were of much lower energies as determined by small-angle scattering measurements. A pair of very small angular divergence was produced in the central core 4 800 microns from the point of origin of the nuclear interaction. Assuming that the pair were produced by a gamma-ray from the decay of a neutral meson, a lower limit of 2×10^{-15} sec was deduced for its mean life. Both the angular and the energy distribution of the emitted particles is in good agreement with the assumption that in the centre-of-mass system the mesons are emitted in two distinct cones of angular width of about 30° forward and backward with reference to the direction of the primary proton. The average multiplicity of 15 agrees with the recent calculation by Fermi, and according to his prediction about one-half of the particles could be made up of nucleon-antinucleon pairs. A.

537.591.8

2811. The origin of cosmic ray stars. J. B. Harding. *Phil. Mag.*, **42**, 63–73 (*Jan.*, 1951).

Estimates for the energy and momentum lost by particles which produce stars when passing through the nuclei in a photographic emulsion support the conclusions reached in a previous paper [Abstr. 5537

(1949)] that the majority of disintegrations are not produced by neutrons which are captured in a single nuclear encounter. The ratio of these two quantities, which have been obtained from the detailed statistical analysis of the various particles produced in nuclear disintegrations, suggests that nuclei are partially transparent to high energy neutrons which at 3 600 m have sufficient energy to produce a small number of stars. A.

537.591.8

2812. Emission of energetic helium and lithium fragments in nuclear explosions. S. O. C. Sörensen. *Phil. Mag.*, **42**, 188–201 (*Feb.*, 1951).

A phenomenological description is given of the processes which lead to the emission of energetic heavy particles from cosmic-ray stars. The frequency, angular distributions and energy spectra of the particles have been determined. These, and an analysis of the associated stars, indicate that the particles cannot be generated by an evaporation process. On the other hand, direct knocking on of the heavy particle by the primary can be excluded. The fragments must therefore result from interactions which are intermediate between these two extreme possibilities. No connection has been found between the ejection of energetic heavy particles and meson showers. A.

537.591.8

2813. The emission of Li^8 from cosmic ray induced nuclear disintegrations. P. E. Hodgson. *Phil. Mag.*, **42**, 207–12 (*Feb.*, 1951).

Li^8 nuclei ejected from cosmic-ray induced disintegrations have been investigated using the photographic plate method. Earlier work has been confirmed, and the frequency and energy distribution of the Li^8 nuclei determined and compared with the predictions of the evaporation theory. Some nuclear reactions involving the production of Li^8 have been identified. A.

537.591.8 : 535.376

Scintillations produced by cosmic rays. *See Abstr.* 2572

537.591.8 : 539.172

2814. The disintegration of lead nuclei by cosmic rays. P. E. Hodgson. *Phil. Mag.*, **42**, 82–94 (*Jan.*, 1951).

Cosmic-ray stars in Pb have been investigated by means of photographic plates in close contact with Pb foil. The energy distributions of protons and alpha-particles from Pb stars have been determined and are compared with the prediction of the evaporation theory. The mean ratio of doubly to singly charged particles is estimated, and an approximate value of the rate of star production in Pb deduced. A.

537.591.8 : 539.172

2815. Observations of slow mesons and nuclear disintegrations in photographic plates exposed under carbon absorbers. J. C. Barton, E. P. George and A. C. Jason. *Proc. Phys. Soc., Lond., A*, **64**, 175–93 (*Feb.*, 1951).

The exposure was made at the Jungfraujoch, altitude 3 457 m, using Ilford type C2 nuclear research emulsions. The frequency of stars under thicknesses of carbon up to 220 g/cm² was measured, the experimental value of the absorption length of the radiation causing them being 166 ± 8 g/cm². The proportion of the stars due to fast π-mesons has been evaluated and, on subtracting this proportion, the absorption length of the radiation responsible for the remainder is found to be 143 ± 10 g/cm². The energy distribution of the stars having from 3 to 20 tracks is found to be of the form $dE/E^{2\cdot6}$, with no apparent discontinuity. The frequencies of slow π- and μ-mesons at various depths is reported. The π-mesons exhibit a transition effect which is interpreted in terms of their production in stars occurring in the carbon absorber. The ratio of negative to positive π-mesons is found to be 3·1 to 1. A table expressing the relation between the number of tracks and the total energy released in nuclear disintegrations in C2 emulsions is given. A.

537.591.8 : 539.172

2816. Disintegrations produced by the nuclear capture of slow negative μ-mesons. E. P. George and J. Evans. *Proc. Phys. Soc., Lond. A*, **64**, 193–8 (*Feb.*, 1951).

The "prong distribution" for the disintegrations produced by the σ-mesons of the cosmic radiation in photographic emulsions exposed below ground is found to be different from that observed in emulsions exposed above ground. The underground distribution contains relatively more "stars" consisting of one prong. The observations are consistent with the hypothesis that most of the σ-mesons below ground are in fact negative μ-mesons and not negative π-mesons. It is concluded that $8\cdot7 \pm 1\cdot7\%$ of the negative μ-mesons captured in the emulsion lead to disintegrations accompanied by the emission of charged particles. The average number of prongs per disintegration produced by the capture of negative μ-mesons is $0\cdot10 \pm 0\cdot02$. The mean number of prongs and the associated prong distribution suggest that a nuclear excitation of about 15 MeV is produced by the capture of a μ-meson. A.

MAGNETISM 538

538.082.742 : 621.317.715 : 621.317.42

2817. Measurement of small differences of magnetic fluxes by a ballistic galvanometer. V. I. Drozhzhina, E. F. Shabalina and R. I. Yanus. *J. Tech. Phys., USSR*, **20**, 698–706 (*June*, 1950) *In Russian.*

The behaviour of a ballistic galvanometer under the action of 2 successive impulses of nearly equal intensity, but of opposite sign, is investigated. The conditions are established under which the ballistic throw due to such impulses furnishes a sufficiently accurate measure of these impulses. The usefulness of the method is shown in measurements of hysteresis losses in soft ferromagnetic specimens in an open magnetic circuit. The comparison of the "impulse difference method" with the usual ballistic method shows the greater convenience of the former, because every B requires one reading only compared with the two of the latter. A mechanism for taking the corresponding periods τ may also be of a very simple

kind. The relative error (δw_k) should be of the same order as that of the conventional method. However, whilst for the latter this represents the optimum attainable, the present method is susceptible of further improvements in this respect (reduction of τ/T, increase of R or reduction of L of the galv. circuit, or else using the galv. in fluxmeter conditions).

B. F. KRAUS

538.082.743 : 621.317.4 : 621.318.013

2818. An oscillation type magnetometer. J. H. E. GRIFFITHS AND J. R. MACDONALD. *J. Sci. Instrum.*, **28**, 56–9 (*Feb.*, 1951).

A simple method of measuring the saturation magnetization of thin plane samples of ferromagnetic materials is described. In this method the sample performs oscillations in a uniform magnetic field about an axis which lies in the plane of the sample and is at right angles to the magnetic field. The method was tested by measurements on sheet nickel and Supermalloy 0·1 mm thick and has been used with films of nickel down to 0·1 μ thick. A.

538.083.9 : 538.63

2819. A simple means of measuring large magnetic fields. G. K. T. CONN AND B. DONOVAN. *J. Sci. Instrum.*, **28**, 7–9 (*Jan.*, 1951).

Measurement of magnetic field strength by determining the electrical resistance of Bi is rarely used nowadays because of the poor cohesion and erratic behaviour of the specimens. Measurement of an electrical resistance is easy, quick and should be reliable. Thin, reliable specimens of Bi with a high resistance can be readily prepared by drawing down in soda glass. Very small probes to explore the distribution of field may be made by winding a close coil of the crystalline wire so obtained, and specimens prepared in this manner have proved entirely reliable. Such specimens are not isotropic, a factor which may limit the usefulness in some applications. A.

538.1 : 538.221

2820. Progressive intermittent activation in some ferromagnetic alloy systems. R. FORRER. *C.R. Acad. Sci., Paris*, **231**, 1444–6 (*Dec.* 18, 1950) *In French.*

Application of the previously introduced concept [Abstr. 5943 (1950)] is made to Fe–Ni, Pt–Co, Pt–Cr, Pt–Mn. E. P. WOHLFARTH

538.113

2821. Theory of the nuclear hyperfine structure of paramagnetic resonance spectra in crystals. A. ABRAGAM AND M. H. L. PRYCE. *Proc. Roy. Soc. A*, **205**, 135–53 (*Jan.* 22, 1951).

Starting from the states of a free ion, neglecting spin-dependent terms in the energy, successive steps of perturbation calculation introduce the effect of the crystalline electric field, the spin-orbit and spin-spin interactions, the coupling with an external magnetic field, and the coupling between the nucleus of the ion and the electrons. The self-consistent field approximation, in which the state of the free ion is described by a single electronic configuration, is found to be inadequate, and it is found necessary to consider admixtures, through configurational coupling, of configurations in which there are unpaired *s*-electrons, as these contribute significantly to the hyperfine splitting. A review of the application of the theory to the ions of the Fe transition group is given. A.

538.114

2822. The propagation of order in the simple cubic lattice. T. OGUCHI. Letter in *J. Chem. Phys.*, **18**, 1517 (*Nov.*, 1950).

Low- and high-temperature series expressions are derived for the correlation probability between two spins separated by n lattice sites, C(0, n), as dependent on J/kT, where J is the exchange integral. The paramagnetic susceptibility is also calculated.

E. P. WOHLFARTH

538.114

2823. Two comments on the limits of validity of the P. R. Weiss theory of ferromagnetism. P. W. ANDERSON. Letter in *Phys. Rev.*, **80**, 922–3 (*Dec.* 1, 1950).

These are (1) the conditions placed on the topology of the crystal lattice for the crystal to be ferromagnetic are not, as appears at first sight, strictly equivalent to those imposed by the Bloch spin wave treatment, (2) the Weiss theory gives an "anti-Curie point" at low temperatures, in contradiction with observation [see Abstr. 1093 (1949)]. E. P. WOHLFARTH

538.114

2824. Studies of the propagation velocity of a ferromagnetic domain boundary. H. J. WILLIAMS, W. SHOCKLEY AND C. KITTEL. *Phys. Rev.*, **80**, 1090–4 (*Dec.* 15, 1950).

Experimental results are given on the velocity of propagation of a single-domain boundary in a crystal of silicon iron with a simple domain structure. In weak applied magnetic fields ($\sim 0{\cdot}003$ oersted) the velocity is given by a relation of the form $v = G(H - H_0)$, where G is a constant ~ 4 cm/sec/oersted in this crystal, and $H_0 \simeq 0{\cdot}003$ oersted is the starting field. Calculation of the eddy current losses accompanying the motion of a plane boundary gives a theoretical expression for G in good agreement with experimental values; the predicted linear dependence on the resistivity was approximately verified by measurements at 78°, 194° and 293°K. In stronger fields (> 5 oersteds) there is evidence that the wall closes on itself, and the experimental velocity of collapse of the wall as deduced from flux changes agrees with the theoretical result based on a model of eddy current losses accompanying a collapsing cylindrical boundary. The results have a bearing on the well-known eddy current anomaly, namely, the fact that the total loss in a ferromagnetic material undergoing a.c. magnetization is often two or three times larger than the eddy-current and hysteresis losses calculated in the usual way assuming a spatially uniform and isotropic classical permeability. A.

538.122 : 621.3.013

2825. Improvements in visual depiction of magnetic lines of force by means of a gas discharge. F. BLAHA AND J. A. SCHEDLING. *J. Appl. Phys.*, **22**, 11–13 (*Jan.*, 1951).

The article shows how lines of force of various magnetic fields can be visually depicted in 3 dimensions by means of a gas discharge. The method is illustrated by several photographs proving especially its applicability when investigating fields of small geometrical dimensions. A.

538.213

2826. High frequency permeability of ferromagnetic materials. F. V. Webster and K. S. Driver. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 1040 (*Dec.*, 1950).

A note on the authors' earlier paper [Abstr. 508 (1951)]. It is pointed out that there may be deviations from the simple monotonic decrease of the inductive permeability with increasing frequency shown in that paper. E. P. WOHLFARTH

538.214 : 548.0

2827. Susceptibility and magnetic anisotropy of indium single crystals. J. Verhaeghe, G. Vandermeerssche and G. Le Compte. Letter in *Phys. Rev.*, **80**, 758 (*Nov.* 15, 1950).

538.22

2828. Some magnetic conversion spectra. G. S. Gorelik. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 2) 174–86 (1950) *In Russian.*

This is a summary of a special branch of magnetic spectroscopy. The basic phenomenon is the setting-up of an alternating e.m.f. in a winding around a ferromagnetic wire through which an audio-frequency current is sent. The arrangement is such that the alternating magnetic field has no component normal to the winding. This phenomenon is explained by the non-linearity of the ferromagnetic (the discoverer, I. L. Bershtein, called this the "transverse flux density"). The spectrum of the e.m.f. of this transverse flux density is the magnetic conversion spectrum, and it consists of a continuous and a discrete spectrum, related to the Barkhausen domains. The main results obtained in 1949–1950 by Bershtein, Goronina, Zhukova, Grachev, Pumper, Borovitskii and Macfarlane are discussed. B. F. KRAUS

538.221

2829. The energetic anisotropy of nickel. L. V. Kirenskiĭ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 209–11 (1950) *In Russian.*

The energy u per unit volume of magnetized Ni when the spin has direction cosines l, m, n, with respect to a 4-fold axis is given by $u = u_0 + k_1(l^2m^2 + m^2n^2 + n^2l^2) + k_2(lmn)^2$ where u_0 represents the energy of magnetization along a 4-fold axis. Measurements were made of the mechanical couple on a spherical single crystal of Ni from 90°K to 600°K. The variation of k_1 with temperature [$k_1 = k_0 \exp(-aT^2)$] [N. L. Bryukhatov and L. V. Kirenskii, *J. Exp. Theor. Phys., USSR*, **6**, 198 (1938)] was confirmed. At 90°K k_1 has the value $-59{\cdot}6 \times 10^4$ and at 292°K $4{\cdot}73 \times 10^4$ ergs/cm³. At 285°K $k_2 = -0{\cdot}5 \times 10^4$ ergs/cm³. A. L. MACKAY

538.221

2830. Single domain structure in ferromagnetics and magnetic characteristics of finely dispersed substances. E. Kondorskiĭ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 213–16 (1950) *In Russian.*

538.221

2831. Theory of magnetic properties of anisotropic permanent magnet alloys. K. Hoselitz and M. McCaig. Letter in *Phys. Rev.*, **80**, 757–8 (*Nov.* 15, 1950).

538.221

2832. Ferromagnetic resonance absorption by Mo-permalloy at 3 000 Mc/sec. J. Itoh and T. Akioka. *J. Phys. Soc., Japan*, **5**, 447–52 (*Nov.–Dec.*, 1950).

Ferromagnetic resonance absorption and resonance dispersion were investigated by Mo-permalloy at 3 000 Mc/s. The results obtained are in good agreement with Kittel's theory, provided that relaxation constant is assumed to be proportional to magnetic field strength. The g-factor is determined from the extrapolated value of resonance field to zero width of the sample which is 2·11. A.

538.221 : 537.226.2 : 537.311.32

2833. Oxide ferromagnetic materials. E. Flegler. *Arch. Elektrotech.*, **40** (*No.* 1) 4–16 (1950) *In German.*

Measurements of the electrical conductivity, permittivity and permeability of γFe_2O_3 and of samples of CuZn ferrite indicate that the variation of these quantities with frequency in the range 10^5–10^{10} c/s is in part explained by eddy current phenomena, but the effects of sintering temperature and of different grinding processes suggest that part of the observed frequency variation is due to inhomogeneities in the structure of the material. A. E. De Barr

538.221 : 538.23

2834. Note on the inertia and damping constant of ferromagnetic domain boundaries. C. Kittel. Letter in *Phys. Rev.*, **80**, 918 (*Dec.* 1, 1950).

A calculation by Döring [Abstr. 4085 (1949)], leading to an expression for the effective mass of a Bloch wall, is generalized to include the case where the intrinsic relaxation frequency of the material is high. An expression is derived for the kinetic energy of the wall, and a general formula for the velocity is given which is applicable to cubic as well as hexagonal crystals. E. P. WOHLFARTH

538.221 : 548.7

2835. The magnetic anisotropy of $\alpha - NiSO_4.6H_2O$ between 13 and 295°K. A torsion balance for magnetic anisotropy measurements. J. W. Stout and M. Griffel. *J. Chem. Phys.*, **18**, 1449–54 (*Nov.*, 1950).

The magnetic anisotropy of single crystals of $\alpha - NiSO_4.6H_2O$ has been measured at temperatures between 13 and 295°K. Two crystals of different origin gave concordant results. The difference in magnetic susceptibility between directions parallel and perpendicular to the tetragonal crystallographic axis is given by $\chi_\perp - \chi_\parallel = 1{\cdot}37 \times 10^{-5} + 1{\cdot}502 \times 10^{-2}/T + 1{\cdot}686/T^2$. The susceptibility difference was independent of field strength up to 10 000 gauss over the temperature range investigated. The results are discussed in connection with the theoretical treatment of the susceptibility of Ni salts by Schlapp and Penney. A torsion balance for the magnetic anisotropy measurements is described. A.

538.221 : 548.7

2836. The magnetic anisotropy of manganous fluoride between 12 and 295°K. M. Griffel and J. W. Stout. *J. Chem. Phys.*, **18**, 1455–8 (*Nov.*, 1950).

The magnetic anisotropy of single crystals of MnF_2, a typical antiferromagnetic substance, has been measured over the temperature range 12 to 295°K. At temperatures above 100°K the anisotropy is of the order of 0·1% of the susceptibility and the

greater susceptibility is in the direction of the *c* axis of the tetragonal crystal. Below 70°K the anisotropy becomes extraordinarily large and the susceptibility in the direction of the *c* axis is smaller than that perpendicular to this axis. Within the limit of experimental error, the anisotropy was independent of field strength up to 10 000 gauss. From the present measurements, combined with those of previous investigators on the powder susceptibility, the directional susceptibilities parallel and perpendicular to the *c* axis have been calculated. As the temperature is lowered from 70 to 14°K, the perpendicular susceptibility increases by about 12% and the parallel susceptibility approaches zero at zero temperature. These results are discussed in connection with the theory of antiferromagnetism proposed by Van Vleck. A.

538.222

2837. A method for measuring paramagnetic absorption on small samples. R. P. Lacroix, C. E. Ryter and C. R. Extermann. Letter in *Phys. Rev.*, **80**, 763 (*Nov.* 15, 1950).

538.222

2838. The magnetic susceptibility of copper sulphate. R. J. Benzie and A. H. Cooke. *Proc. Phys. Soc., Lond., A*, **64**, 124–8 (*Feb.*, 1951).

Measurements of the magnetic susceptibility of Cu sulphate pentahydrate have been made at temperatures between 20°K and 1°K on a single crystal specimen. It is found that the susceptibilities measured in different directions with respect to the crystallographic axes follow a Curie–Weiss law, with different Curie constants but a fixed Weiss constant of $-0{\cdot}6°$. The discrepancy between this result and that of Krishnan and Mookherji is attributed to temperature-independent paramagnetism. A.

538.24

2839. Temperature dependence of the magnetization curves and hysteresis loops of highly coercive alloys. Ya. S. Shur and N. A. Baranova. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 225–8 (1950) *In Russian.*

538.24

2840. Influence of directional stresses on the form of the magnetization curve in strong fields. L. V. Kirenskiĭ and L. I. Slobodskoĭ. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 457–9 (1950) *In Russian.*

538.24

2841. Dependence of the coercive force of powdered highly coercive alloys on particle size. T. D. Zoton and Ya. S. Shur. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 687–90 (1950) *In Russian.*

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 530.145

2842. On the elimination of divergencies from classical electrodynamics. S. N. Gupta. *Proc. Phys. Soc., Lond., A*, **64**, 50–3 (*Jan.*, 1951).

It is shown that the divergencies in classical electrodynamics may be removed by subtracting the self-energies of isolated electrons by means of a modification of the usual expression for the force density in an electromagnetic field. The results obtained are equivalent to those of Dirac and Wentzel.

538.311

2843. An apparatus for studying the laws of the magnetic field due to an electric current in a long straight conductor. D. Owen. *Brit. J. Appl. Phys.*, **2**, 5–7 (*Jan.*, 1951).

It is impracticable to measure directly the magnetic field due to an electric current in a single long straight conductor, since a complete circuit is necessary. By using a narrow rectangular coil the field is, within reasonable limits of accuracy, the same as that due to the two long sides regarded as infinite in length. The formulae for the field are simple for points along two axes relative to the coil, provided the points are not too far removed from its centre. The linearity of suitable graphs of a series of observations constitutes a verification of the law derived for a single straight conductor, and from the graphs values of the horizontal component of the earth's magnetic field can be determined. Two experimental methods, involving the location of neutral points, are described. A.

538.52 : 621.318.42

2844. A 100-kilowatt water-cooled solenoid. J. M. Daniels. *Proc. Phys. Soc., Lond., B*, **63**, 1028–34 (*Dec.*, 1950).

Design data and constructional details are given for a small water-cooled solenoid, which, for a consumption of 100 kW, produces a field of 14·7 kilogauss, uniform to within $\pm \frac{1}{2}\%$ in a cylindrical volume 6 cm long and 4 cm diameter. The solenoid contains no iron or other ferromagnetic material, and is used for experiments on adiabatic demagnetization. A.

538.551.25/.3 : 621.3.018

2845. Non-linear oscillations, interferences and fluctuations. G. S. Gorelik. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 2) 187–98 (1950) *In Russian.*

A comprehensive survey of Mandelstam's work in the field of non-linear oscillations and related problems and its continuation by Bershtein. It is claimed that Mandelstam was the first to discover the identity of Debye's waves with Einstein's "formal waves." The author's own contribution to the problem of non-linear oscillations of a valve generator is included in the historical account of the development, but was separately published [*J. Exp. Theor. Phys.*, **20**, 351 (*April*, 1950) Abstr. 3056 B (1950)]. B. F. KRAUS

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 621.3.018

2846. On the problem of excitation of electromagnetic oscillations. B. Ya. Moĭzhes. *J. Tech. Phys., USSR*, **20**, 707–15 (*June*, 1950) *In Russian.*

A general method is developed for problems in electrodynamics whereby Maxwell's equations are reduced to 2 independent equations each having 1 scalar function (component of the field or the component of an auxiliary function) for which separate boundary conditions must be deduced; this turns out

particularly well, with the defined boundary conditions in cylindrical and spherical system of co-ordinates (*TE* and *TM* waves). The excitation of a cylindrical pipe and a sectoral horn is considered using the above method. Z. F. WOJNAR

538.561 : 621.385.1.029.6 : 621.396.615.14

2847. Millimeter waves. J. R. PIERCE. *Physics Today*, **3**, 24–9 (*Nov.*, 1950).

A general descriptive account of methods used for the generation of both incoherent and monochromatic mm-waves. The limitations on the use of existing types of valve are discussed, and a travelling-wave tube circuit for 6 mm waves is described. The possibilities of using relativistic Doppler effects are mentioned. A. H. W. BECK

538.565 : 621.396.611.4

2848. The application of the method of curvilinear co-ordinates to calculation of the π-mode end-space resonator. V. L. PATRUSHEV. *J. Tech. Phys., USSR*, **20**, 727–34 (*June*, 1950) *In Russian.*

The π-mode end-space resonator, having rotational symmetry, is considered as a concentric line loaded by volume and, using the corresponding system of curvilinear co-ordinates, the problem is solved precisely. The static field between the cylinder with bottom and a thin coaxial pivot and the dynamic field, arising from the examined cavity into a force of oscillatory region in it, is determined by solving Laplace's and wave equations respectively in a given curvilinear system of co-ordinates. Z. F. WOJNAR

538.565.4 : 537.228.1

2849. Crystal systems with low loss. R. B. FRY AND W. J. FRY. *J. Appl. Phys.*, **22**, 198–200 (*Feb.*, 1951).

Approximate formulae are derived for computing the effect of mechanical resistance on the electrical characteristics of a piezoelectric crystal system for the case of a general reactive termination and low loss. A comparison of values computed on the basis of these formulae and exact calculations is presented. A.

538.565.5 : 621.396.611.4

2850. On some results in the theory of coupled electromagnetic cavity resonators. E. LEDINEGG AND P. URBAN. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 180–96 (1950) *In German.*

The method and results of a previous paper [*ibid.*, **2**, 198–214 (*Sept.*, 1948) Abstr. 2228 B (1949)] are extended and a general theory is now given for the oscillations of a system of coupled resonators which are of interest in cm-wave technique. The coupling frequencies are calculated and compared with experimental results, and the influence of damping in the resonator is considered. An analysis is made of the oscillations of a system consisting of 2 circular cylinders coupled by a concentric cable. L. S. GODDARD

538.566 : 621.3.011

2851. Properties of plane inhomogeneous electromagnetic waves. G. BONFIGLIOLI. *Alta Frequenza*, **19**, 259–66 (*Oct.–Dec.*, 1950) *In Italian.*

Solutions of Maxwell's equations of the form $E \equiv Ey(y, z) \exp(-\beta x - i\alpha x)$ are studied. At any frequency there is a continuous infinity of propagation modes. Such waves cannot propagate in an unbounded perfect dielectric. In a bounded dielectric, or in any conducting medium, there are periodic, exponential and polynomial solutions. L. PINCHERLE

538.566 : 621.3.011 : 621.396.671

2852. On the diffraction of electromagnetic waves by small circular disks and holes. C. J. BOUWKAMP. *Philips Res. Rep.*, **5**, 401–22 (*Dec.*, 1950).

Deals with the diffraction of a plane-polarized electromagnetic wave by a conducting circular disk for the case of normal incidence. Integro-differential equations are derived for the currents induced in the disk. These equations are approximately solved on the assumption that the radius of the disk is small compared to the wavelength. Six terms of a power-series solution in the basic variable ka are derived, where k is the wave number and a the radius of the disk. The scattered field on the surface of the disk is calculated to the same degree of accuracy, and also the field in the wave zone. An expression is obtained for the scattering coefficient of the disk. Finally, Babinet's principle is applied to obtain the corresponding solution for the diffraction of a plane wave by a circular hole in an infinite plane conducting screen. A.

538.566 : 621.392.26

2853. The radiation of unsymmetric electromagnetic waves from an open end of a circular waveguide. L. A. VAĬNSHTEĬN. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 485–8 (1950) *In Russian.*

The e.m. field arising as a result of diffraction of the electric wave at an open end of the pipe has two longitudinal components: the electric and the magnetic Hertzian vectors (sine and cosine forms). The strict theory of its distribution is developed and illustrated by examples. Z. F. WOJNAR

538.566.2 : 621.392.26

2854. On diffraction of waves at an open end of the circular waveguide the diameter of which is considerably greater than the wavelength. L. A. VAĬNSHTEĬN. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 5) 909–12 (1950) *In Russian.*

The physical sense of the formulae derived in author's previous works [see preceding Abstr.] for the precise calculation of the radiation characteristics when $r > \lambda$ is considered. The quoted analogy of the exact solution of one of the diffraction problems adds to the general theory of diffraction, particularly to the form in which the diffraction picture at the opening is considered as a result of wave interference caused by the various edge elements of this opening. Z. F. WOJNAR

538.566 : 621.392.26

2855. On the diffraction at a plane screen in a waveguide. R. MÜLLER. *Z. Naturforsch.*, **5a**, 617–21 (*Nov.*, 1950) *In German.*

A general formulation of the problem is given. The particular case of a screen with a circular opening in a concentric cylindrical tube is particularly considered, and it is shown that the diffracted field of a cylindrically symmetrical *E*- or *H*-wave may be described only by *E*- or *H*-waves respectively, but that if the incident wave depends on the azimuth there is a partial transformation between the two types. L. PINCHERLE

538.566 : 621.392.26

2856. Expandability of a wave-guide field in terms of normal modes. J. Van Bladel. *J. Appl. Phys.*, **22**, 68–9 (*Jan.*, 1951).

This article justifies the fact that the fields in a waveguide can be expanded as a linear combination of normal modes. The proof consists in showing that (*a*) this expansion is possible for the *z* components of the fields and modes, and (*b*) that, in 3 dimensions, the fields as a whole are equal to a linear expansion of modes with precisely the same coefficients as were found in the expansion of the *z* components. A.

538.566 : 621.392.26

2857. Propagation characteristics in a coaxial structure with two dielectrics. A. Baños, Jr., D. S. Saxon and H. Gruen. *J. Appl. Phys.*, **22**, 117–23 (*Feb.*, 1951).

The propagation characteristics for circularly symmetric *TM* modes offer many points of interest. For a given mode, the pertinent parameters are the ratio of the permittivities of the two media involved, the ratio of the two radii, and the operating frequency, expressed, say, in terms of the cut-off frequency for the empty guide. The phase velocity for a given propagating mode may lie between the phase velocities corresponding to each of the two unbounded dielectrics and, by proper choice of parameters, it is always possible to obtain a phase velocity of a preassigned value higher than the lower of the two velocities for the unbounded media. This suggests the possibility of using such structures in linear accelerators. The results of an extensive computation are presented in the form of families of curves showing the dependence of the propagation constant and of the phase velocity on the parameters of interest. Power flow and field distribution are also discussed. A.

538.566 : 621.396.671

2858. Electric dipoles in the presence of elliptic and circular cylinders. W. S. Lucke. *J. Appl. Phys.*, **22**, 14–19 (*Jan.*, 1951).

A theoretical examination is made of the problem of the electromagnetic fields of electric dipoles in the presence of an infinitely long, perfectly conducting cylinder. Application of the Green's function method to this problem yields expressions for the fields in terms of an integration in the complex plane. Simplified expressions for far zone fields are obtained through the known result of the complex integration for the far zone conditions. Results are given for both circular and elliptic cylinders. In the latter case, it is possible to treat the problem of dipoles in the presence of a ground plane which is finite in one dimension and infinite in the other, since this is equivalent to an elliptic cylinder with a vanishing minor axis. Polar diagrams of calculated far zone fields are included for a number of cases. A.

538.566 : 621.396.671

2859. Applications of potential theory to the design of linear arrays. T. T. Taylor and J. R. Whinnery. *J. Appl. Phys.*, **22**, 19–29 (*Jan.*, 1951).

The polynomial formulation of the linear array problem introduced by Schelkunoff is studied from the point of view of potential theory. An electrical analogy results which is not only very helpful in qualitative thinking about the problem, but which also makes possible the construction of an analogue computer for the synthesis of arrays to produce a desired radiation pattern, and for the evaluation of existing arrays. Such a computer has been built, and tested on known patterns with remarkable success. Several theorems concerning the effect of the roots of the polynomial on the magnitude and phase of the space factor of an array are given. Some of the most important consequences of these are the lack of uniqueness in the array synthesis problem, and the evaluation of known methods of synthesis which consider only constant-phase patterns. A method of analysis is sketched which in principle does the same thing as the computer, and the difficulties in applying this are described. It is concluded that the computer would be preferable for a wide range of practical problems. A.

538.566 : 621.396.671

2860. Theory of the circular diffraction antenna. H. Levine and C. H. Papas. *J. Appl. Phys.*, **22**, 29–43 (*Jan.*, 1951).

The circular diffraction antenna consists of a coaxial waveguide fitted with an infinite-plane conducting baffle, and open to free space. An equivalent circuit description, appropriate to principal-mode propagation in the coaxial region, is investigated theoretically. Variational expressions for the circuit parameters are derived, and used for accurate numerical evaluation. A.

538.566 : 621.396.671

2861. Oh the directional patterns of polystyrene rod antennas. R. B. Watson. *J. Appl. Phys.*, **22**, 154–6 (*Feb.*, 1951).

Experimental and theoretical directional patterns are compared for 3 polystyrene rod aerials of lengths of 4–10 wavelengths, retaining relative shape in the length direction. The comparison shows that the apparent index of refraction, *n*, decreases with increasing length. Accordingly, the directional patterns are less sharp than might be expected from the estimated values of *n* which are constant for a constant relative shape. A.

538.566.2

2862. Propagation of electric waves along stratified and continuously varying plasmas. W. O. Schumann. *Z. Naturforsch.*, **5a**, 612–17 (*Nov.*, 1950) *In German.*

The plasma is bounded in the *y* direction, its density being a function of *y*. An *E*-wave propagates along *x*. For a plasma of 2 layers, the inner of which is denser, there are 2 propagation regions, in each of which the phase velocity v varies from c to 0. If the plasma density varies continuously to a very high value at the centre, the wave, at high frequencies, is confined to a thin layer near $y = 0$, and $v \to 0$. For a plasma of constant density and frequency ω_0, ending with a linear transition layer, propagation is possible only when $\omega^2 < \omega_0^2/2$. L. Pincherle

538.566.2 : 535.39

Propagation of electromagnetic waves in stratified media. Thin films. *See Abstr.* 2575

538.566.2 : 551.594.6 : 621.396.11

2863. The propagation of a radio-atmospheric. K. G. Budden. *Phil. Mag.*, **42**, 1–19 (*Jan.*, 1951).

The author shows that if one surface of the wave-

guide is an imperfect conductor, then all the modes, including the zero-order mode, are heavily attenuated below a certain critical frequency. There are two modes whose amplitudes are much greater than those of all other modes, and these both give an oscillatory response to a lightning flash at a great distance. There is no longer any mode of propagation which would give an undistorted impulse at a great distance from the source. The critical frequency depends most markedly on the height of the ionosphere, and to a smaller extent on the characteristics of the ionized medium. The changes in the measured curves of attenuation versus frequency from day to night, and during sudden ionospheric disturbances are consistent with the changes in the height of reflection of very long waves which are known to occur at these times. The relation between the treatment of propagation in terms of waveguide modes, and in terms of successively reflected "rays" is discussed. A.

538.566.2 : 551.594.6 : 621.396.822 : 621.396.11

2864. The use of atmospherics to study the propagation of very long radio waves. F. F. GARDNER. *Phil. Mag.*, **41**, 1259–69 (*Dec.*, 1950).

The "level" of integrated atmospherics received on narrow-band receivers tuned to a series of different frequencies between 3·5 and 50 kc/s has been recorded. The bandwidth of the receivers was about 200 c/s and the time of integration about 1 min. The results were analysed so as to eliminate the unknown spectral distribution of energy at the source, and so as to show up the way in which propagation conditions changed with distance and with time of day. The most significant effect is a marked attenuation of waves of frequency below 10 kc/s when travelling over distances of 1 000 km or more. This attenuation is discussed and is related to the quasi-sinusoidal waveform often assumed by atmospherics which have travelled great distances. A decrease in the level of atmospherics has been found to occur during sudden ionosphere disturbances on frequencies below about 10 kc/s. This contrasts with the known increase on frequencies above about 20 kc/s. A.

538.566.2 : 621.396.11

2865. Theory of the propagation of electromagnetic waves in an atmospheric wave-guide. T. KAHAN AND G. ECKART. *Ann. Phys., Paris*, **5**, 641–705 (*Nov.–Dec.*, 1950) *In French.*

A rigorous theory is presented of propagation in a stratified dielectric medium bounded by a plane perfect conductor. The solution is given in the form of integrals in which the singularities and contours of integration in the complex plane essentially explain the physical phenomena. An attempt is made to give a picture of phenomena which are produced in the space above the waveguide as well as within it.

W. J. G. BEYNON

538.566.2 : 621.396.11

2866. Asymmetry in the propagation of waves. P. NIGUET. *Onde Elect.*, **30**, 533–41 (*Dec.*, 1950) *In French.*

A study of the non-reciprocity observed for transmission between Paris and Algiers on 12 Mc/s which is particularly pronounced during the summer. The author considers possible theoretical explanations of this apparent contradiction of the laws of optics and concludes that the cause is that the ionized layers in the ionosphere are not parallel to the earth's surface.

J. M. HOUGH

538.566.2 : 621.396.11

2867. Effective earth's radius for radiowave propagation beyond the horizon. W. MILLER. *J. Appl. Phys.*, **22**, 55–62 (*Jan.*, 1951).

The geometrical optical arguments underlying the equivalent earth's radius approximation are extended to non-horizontal rays. The appropriate wave equation for a non-uniform, but spherically symmetric, region is derived in a natural way. The notion of a "primary field" with the form e^{ikR}/R at the source is dropped in favour of a solution to the wave equation in terms of a Green's Function. The formal solution thus obtained is seen to contain the known solutions for a uniform medium. For the non-uniform case, the solutions to the radial equation are found by a technique due to Langer. These functions account for the index variation near the earth without making unwarranted assumptions about the behaviour at greater heights. The formal series obtained is summed by the Watson technique. The first term in this series (lowest mode) alone determines the field at large distances and indicates that one may account for standard atmospheric refraction by using an effective earth's radius. A.

538.566.2 : 621.396.11.08

2868. Polarimeter for the study of low frequency radio echoes. A. H. BENNER AND H. J. NEARHOOF. *Rev. Sci. Instrum.*, **21**, 830–4 (*Oct.*, 1950).

The instrument uses two crossed loop aerials to split the elliptically polarized echo into quadrature components which after identical amplification are recombined into an ellipse on an oscilloscope and photographically recorded. The signals are obtained from a 150 kc/s transmitter pulsed with Gaussian-shaped pulses of 150 μsec at a repetition rate of 1·5626 pulses/sec. The polarimeter incorporates a device to indicate the sense of rotation of the ellipse. Some preliminary experimental results are given.

J. M. HOUGH

538.566.3

2869. Group and phase velocities from the magneto-ionic theory. H. A. WHALE AND J. P. STANLEY. *J. Atmos. Terr. Phys.*, **1** (*No.* 2) 82–94 (1950).

When a radio wave is transmitted through a medium consisting of free electrons it is well known that the product of the refractive index μ and the "group refractive index" μ' is equal to unity. When a steady magnetic field is imposed on the medium, μ becomes a complicated function of wave frequency and the direction of propagation, μ' is even more complicated and the product $\mu\mu'$ is no longer equal to unity. It is shown that it is then convenient to consider values of the product $\mu\mu'$ for different frequencies and directions of propagation and sets of curves are given from which the behaviour of this product can be visualized as both wave-frequency and direction of propagation are varied. The curves were computed by the use of the EDSAC electronic computer. The use of the curves and the conditions under which they may be applied are discussed briefly. A.

538.566.3 : 621.396.11

2870. The absorption of long and very-long waves in the ionosphere. J. P. STANLEY. *J. Atmos. Terr. Phys.*, **1** (*No.* 2) 65–72 (1950).

Experimental observations on a series of low frequencies have been used to show that models of the ionosphere in which the ionization density increases linearly or parabolically with height are unsuitable for explaining long and very-long-wave reflection phenomena. Agreement with observation can, however, be obtained if an absorbing or *D*-region of small ionization density but several km in thickness is assumed to lie below the main reflecting region. A model in which the ionization density increases exponentially with height is found to include such an absorbing region; this model is used to deduce values for the ionization gradient and the electronic collision frequency in the very-long-wave reflecting region. A.

538.566.3 : 621.396.11

2871. The damping of extra-ordinary components in the ionosphere E_1-layer. W. BECKER. *J. Atmos. Terr. Phys.*, **1** (*No.* 2) 73–81 (1950).

The experimental observation, that no extra-ordinary radio echoes can be received from the normal *E*-layer round sunrise and sunset for frequencies within the range from the gyro-frequency (1·39 Mc/s) to about 2·5 Mc/s, is shown to be in accordance with numerical considerations. The reason for this is to be found in the high mean electron collision frequency, which prevents the real part of the refractive index from becoming substantially less than unity, a necessary condition for appreciable reflection. It is further shown that, in such cases, the extra-ordinary limiting frequency of the E_1-layer can be identified as the frequency at which the first echoes are received from a layer at a greater height. A.

538.566.3 : 621.396.11

2872. On the evaluation of ionospheric observations. W. BECKER. *Arch. elekt. Übertragung*, **4**, 391–400 (*Oct.*, 1950) *In German.*

It is usual to calculate ionospheric results on the basis of ray theory. The present paper investigates the justification for this by attempting a rigorous solution of Maxwell's equations for the case of an idealized model of the ionospheric layer due to Epstein, ignoring the effect of the earth's magnetic field. It is shown that the ray theory is not applicable in all cases, but that it is difficult to know whether the conditions are satisfied from the experimental data. The results are applied to experimental data. J. M. HOUGH (R)

538.566.3 : 621.396.11

2873. Direction of arrival of ionospheric radio waves. W. ROSS. *Nature, Lond.*, **166**, 1011–14 (*Dec.* 16, 1950).

A survey is made of published work on ionospheric irregularities in the form of tilts and "roughness." Long- and short-period changes and the magnitude of the irregularities are discussed. W. J. G. BEYNON

538.567 : 621.385.16.029.6

2874. On the interaction between a travelling e.m. wave and an electron beam propagating in a cylindrical system perpendicularly to mutually perpendicular constant electric and magnetic fields. R. WARNECKE AND O. DOEHLER. *C.R. Acad. Sci., Paris*, **231**, 1132–4 (*Nov.* 20, 1950) *In French.*

In this type of travelling-wave tube the constant magnetic field is produced by a current flowing in the inner conductor of a co-axial delaying circuit. It is proved that the gain is then relatively high, reaching, for instance, 2·5 db/cm at 1 500 Mc/s, for a useful power of 100 W and reasonable working conditions. The effect of various simplifying hypotheses is discussed. L. PINCHERLE

MAGNETIC EFFECTS 538.6

538.632 : 548.0

2875. Hall effect in a selenium single crystal. K. W. PLESSNER. Letter in *Nature, Lond.*, **166**, 1073 (*Dec.* 23, 1950).

538.639

2876. Influence of the thermo-magnetic treatment on the electric resistance of soft magnetic materials. YA. A. SHOR AND I. E. STARTSEVA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 473–5 (1950) *In Russian.*

538.639

2877. Magnetoresistance of bismuth at 3 000 megacycles. C. W. HEAPS. *Phys. Rev.*, **80**, 892–4 (*Dec.* 1, 1950).

The magnetoresistance of Bi for frequencies of 3·5 Mc/s has been found to be of the same magnitude as for steady direct currents. On the other hand, for long i.r. waves (8 μ) the magnetoresistance is zero. Using a resonating Bi cavity and a slotted wave-guide measurements of the standing wave ratio have indicated that magnetoresistance at 3 000 Mc/s is not more than half as big as for direct currents. This small value of magnetoresistance is possibly due to the fact that the skin depth is of the same order of magnitude as the mean free path of electrons in the metal. A.

538.653

2878. The variation of the magnetic permeability of ordinary steels under the influence of mechanical tension. A. LANGEVIN, M. REIMBERT AND E. PAUL. *J. Phys. Radium*, **11**, 596–608 (*Nov.*, 1950) *In French.*

Gives the results of bridge measurements (at 5 000 c/s) of the permeability of 10 mm diameter steel rods subjected to tension. Curves of the change in permeability as a function of applied stress are given, showing that the permeability first increases with stress up to the limit of magnetic reversibility, then remains constant and finally decreases again when the elastic limit of the material is reached. Between the limit of magnetic reversibility and the elastic limit of the material there is a region in which small residual strains are found. A. E. DE BARR

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

2879. Atomic arrangements with given number of neighbours. J. A. WASASTJERNA. *Comment. Phys. Math. Helsingfors*, **14** (*No.* 3) 1–4 (1950).

The number of arrangements $g(N, p, z, x)$ of pN atoms of type A and $(1 - p)N$ of type B on a lattice

having z nearest neighbours, and such that the number of AB pairs is $\frac{1}{2}Nzx$, is inferred by analogy with Chang's expression for $z=2$ to be $(p^p q^q/n^n \lambda^\lambda \mu^\mu \nu^\nu)^N$ where $x = p(p+q\sigma)$, $\lambda = pq(1+\sigma)$, $\mu = qp(1+\sigma)$, $\nu = q(q-p\sigma)$. This is shown to agree with known calculations of special cases. J. R. MADDOX

539.11

2880. On the cohesive energy of metallic lithium. R. A. SILVERMAN AND W. KOHN. Letter in *Phys. Rev.*, **80**, 912–13 (*Dec.* 1, 1950).

The 3rd coefficient E_4 has been calculated in the expansion $E(k) = E_0 + E_2k^2 + E_4k^4$ of the energy of an electron in a state of wave number k in the Li lattice, by an extension of Bardeen's method [*J. Chem. Phys.*, **6**, 367–71 (*July*, 1938)]. The result $E_4 = 0{\cdot}0175$ is unexpectedly small and does not give the expected improvement in the calculated cohesive energy. This energy is 34·9 cal/mol. G. J. KYNCH

539.11

2881. A note on Hildebrand's approximation for thermal pressures in solids. K. HUANG. *Phil. Mag.*, **42**, 202–6 (*Feb.*, 1951).

The validity of a widely used approximation for thermal pressures due originally to Hildebrand is discussed. The distinction between the "vibrational" pressure and the thermal pressure is stressed; Hildebrand's expression is shown to lie intermediate between the two for all temperatures. Since the percentage difference between the two pressures diminishes monotonically with increasing temperature, the accuracy of the approximate expression improves with increasing temperature. But at temperatures comparable with the Debye temperature, Hildebrand's expression is much closer to the vibrational (10% error) than the thermal pressure (40% error). It follows further from the discussion that the linearly extrapolated volume from any temperature to the absolute zero lies intermediate between the real volume at absolute zero of temperature and the volume corresponding to static equilibrium. A.

MOLECULAR STRUCTURE 539.13

539.132

2882. Asymptotic expressions for the energies of certain long molecules. R. D. BROWN. *Aust. J. Sci. Res. A*, **3**, 428–32 (*Sept.*, 1950).

Asymptotic values for the increment in total π-electron energy and in resonance energy for addition of one structural unit to a long polyene and to a long polyacene molecule are derived. The values are obtained, both neglecting and including the overlap integral, by the usual LCAO molecular-orbital method. The results are compared with the corresponding increments for the lower members of each series of molecules calculated by direct summation. A.

539.132

2883. Molecular orbital theory and spectra of monosubstituted benzenes. I. The resonance effect. F. A. MATSEN. *J. Amer. Chem. Soc.*, **72**, 5243–8 (*Nov.*, 1950).

A molecular orbital calculation of the resonance energy, intensity and frequency of absorption and resonance moment of monosubstituted benzenes has been made and the results compared with experiment. Expressions for extent of migration and frequency of absorption first obtained by Sklar and Herzfeld, respectively, are obtained by a perturbation treatment. A.

539.132

2884. Molecular orbital theory and spectra of monosubstituted benzenes. II. Thiophenol. W. W. ROBERTSON AND F. A. MATSEN. *J. Amer. Chem. Soc.*, **72**, 5248–50 (*Nov.*, 1950).

539.132

2885. Molecular orbital theory and spectra of monosubstituted benzenes. III. Compounds of the type $(C_6H_5)_2X$. W. W. ROBERTSON AND F. A. MATSEN. *J. Amer. Chem. Soc.*, **72**, 5250–2 (*Nov.*, 1950).

539.132

2886. Molecular orbital theory and the near ultraviolet absorption spectrum of monosubstituted benzenes. IV. The phenyl halides and the inductive effect. W. W. ROBERTSON AND F. A. MATSEN. *J. Amer. Chem. Soc.*, **72**, 5252–6 (*Nov.*, 1950).

539.132

2887. Molecular orbital theory and spectra of monosubstituted benzenes. V. Styrene, phenylacetylene and phenylcyclopropane. J. F. MUSIC AND F. A. MATSEN. *J. Amer. Chem. Soc.*, **72**, 5256–9 (*Nov.*, 1950).

539.132

2888. Molecular orbital theory and spectra of monosubstituted benzenes. VI. Styrene, phenylacetylene and phenylcycloalkanes. W. W. ROBERTSON, J. F. MUSIC AND F. A. MATSEN. *J. Amer. Chem. Soc.*, **72**, 5260–3 (*Nov.*, 1950).

539.132

2889. Intermolecular forces in benzene and ammonia. V. MYERS. *J. Chem. Phys.*, **18**, 1442–4 (*Nov.*, 1950).

The intermolecular forces between benzene molecules and between ammonia molecules are computed in a semi-empirical manner. The long-range attractive forces are calculated from optical dispersion data and dipole moments, and the short-range repulsive forces are estimated from second virial coefficients. A.

539.132

2890. Asymmetry of inner electron distributions in homonuclear diatomic molecules. H. REISS AND H. SALTSBURG. *J. Chem. Phys.*, **18**, 1461–5 (*Nov.*, 1950).

Disturbances in the distributions of inner shell electrons due to bond formation in homonuclear diatomic molecules have been investigated using a Fermi Thomas type statistics. In the majority of molecules examined the disturbance seems to penetrate only to the shell directly beneath the valence shell. Plots of the number of electrons disturbed versus atomic number are periodic, the disturbance being less for the alkali molecules than for the halogens. In any one group, these plots are remarkably linear. This behaviour has permitted bond distance calculation in Rb_2. It is found to be 4·28 Å. This value is to be compared with the distance 4·32 Å between nearest neighbours in the metal. A.

539.132

2891. The separation of the rotational coordinates from the N-particle Schroedinger equation. C. F. CURTIS, J. O. HIRSCHFELDER AND F. T. ADLER. *J. Chem. Phys.*, **18**, 1638–42 (*Dec.*, 1950).

By group theoretical arguments, it can be shown

that a wave function, ψ^L_μ, for a system of N particles corresponding to a total angular momentum quantum number, L, and a quantum number, μ, referring to the z component of angular momentum may be written as a sum of terms: $\psi^L_\mu = \Sigma_s D^L(R)^*_{\mu s}\chi^L_s$. The $D^L(R)_{\mu s}$ are the representation coefficients for the Lth irreducible representation of the 3-dimensional rotation group, and are functions of the 3 coordinates specifying the orientation of the system of particles in space. The χ^L_μ are functions of the $3N$–6 coordinates specifying the relative configuration of the N-particle system. The set of coupled differential equations for the functions, χ^L_μ, is obtained explicitly. The special case of the 3-particle system is discussed in detail. The present treatment is more directly usable than the previous discussions since the basic equations do not involve implicit relationships between the variables. A.

539.132

2892. The planar vibrations of ethylene and tetradeutero-ethylene: A critical analysis of the potential function. P. TORKINGTON. *Proc. Phys. Soc., Lond., A*, **64**, 32–49 (*Jan.*, 1951).

A careful analysis of the planar modes of vibration of ethylene and ethylene-d_4 is carried out in order (*a*) to determine finally the value of the C=C stretching force constant in these key molecules, (*b*) to find what interactions, particularly those between the two ends of the molecules, are real, and (*c*) to determine the vibrational forms and the potential energy distributions in the normal modes, and how they are affected by altering the potential function. Solutions are obtained both with and without correction for anharmonicity, and estimates are made of the effects of other corrections which may be necessary. The limits found for the C=C stretching constant are $9{\cdot}336$, $9{\cdot}388 \times 10^5$ dyne/cm, with a most probable value of $9{\cdot}343$, the carbon atoms being uncorrected for anharmonicity. The zero-order constant is unlikely to be greater than $9{\cdot}57$. There is detectable real interaction between the two ends of the molecule, for both stretching and bending coordinates. Interactions are discussed. A.

539.132 : 535.338.4

2893. Calculation of the oscillator strengths for certain band-systems of N_2 and C_2. G. STEPHENSON. Letter in *Proc. Phys. Soc., Lond., A*, **64**, 99–100 (*Jan.*, 1951).

The oscillator strengths (*f*-values) for the molecular electronic transitions associated with the second positive system of nitrogen and the Swan and Deslandres bands of carbon are calculated using the hydrogen-ion approximation. A.

539.132 : 535.343

2894. Calculation of the fundamental vibration frequencies of cyclohexane. M. LARNAUDIE. *C.R. Acad. Sci., Paris*, **231**, 1292–3 (*Dec.* 6, 1950) *In French.*

Theoretical treatment based on a chair structure, of symmetry D_{3d}. R. F. BARROW

539.132 : 535.343–15

2895. Errata: Vibrational intensities. I. Theory of diatomic infra-red bands. B. L. CRAWFORD, JR. AND H. L. DINSMORE. Letter in *J. Chem. Phys.*, **18**, 1682–3 (*Dec.*, 1950). See Abstr. 8152 (1950).

539.132 : 541.57

2896. The homopolar bond in the hydrogen molecule. M. F. HOARE AND J. W. LINNETT. *Trans. Faraday Soc.*, **46**, 885–93 (*Nov.*, 1950).

Using two wave functions for the H molecule, the changes in the average electronic kinetic energy have been calculated, both parallel and perpendicular to the internuclear axis, as the 2 H atoms approach one another. The variations in average electronic and nuclear potential energy have been considered. The changes in electronic kinetic energy are related to changes in spreading and curvature of the wave function and an attempt is made to understand the changes in average potential and kinetic energy. At the equilibrium separation R_e the average potential energy is very much less than when the atoms are far apart, the average electronic kinetic energy parallel to the axis is slightly less, and that perpendicular to the axis considerably greater at R_e than when the atoms are far apart. A.

539.133

2897. The vibrational assignment and thermodynamic functions of tetrachloroethylene. P. TORKINGTON. *Trans. Faraday Soc.*, **46**, 894–900 (*Nov.*, 1950).

The specific heat, free energy and heat content functions, and the entropy of tetrachloroethylene are calculated for 8 temperatures over the range 298·15° to 1 500°K, from assumed standard dimensions and from the most probable set of fundamental vibration frequencies. It is shown that if the estimated low frequencies are reasonably correct then measurement of the specific heat at room temperature can be employed to decide between these two frequencies; the magnitude of the specific heat will certainly show whether or not the non-planar vibrations are as low as recently suggested. A.

539.133

2898. Dodecahedral octacovalent bond orbitals. G. H. DUFFEY. *J. Chem. Phys.*, **18**, 1444–5 (*Nov.*, 1950).

Dodecahedral octacovalent bond orbitals of D_{2d} symmetry are considered. The bond orbitals are divided into two groups which may differ widely in composition, the over-all composition remaining sp^3d^4. When the average orbital strength is greatest, it equals 2·981 and the orbitals of group one and group two differ in composition and strength. The concept of orbital strength does not allow us to exclude either the dodecahedral or the tetragonal antiprism structure in AB_8 when A employs the sp^3d^4 configuration. A.

539.133

2899. Nuclear magnetic resonance in methane. J. T. THOMAS, N. L. ALPERT AND H. C. TORREY. Letter in *J. Chem. Phys.*, **18**, 1511 (*Nov.*, 1950).

539.133

2900. The dipole moments of ethylene oxide and carbonyl chloride in benzene solution, and a note on a useful modification of Barclay and Le Fèvre's equation. C. L. ANGYAL, G. A. BARCLAY AND R. J. W. LE FÈVRE. *J. Chem. Soc.*, 3370–3 (*Dec.*, 1950).

In spite of its negative Kerr constant, ethylene oxide shows a smaller apparent moment in benzene solution (1·83 D) than as a gas (1·89 D). Such behaviour is predicted by several empirical relations,

utilizing quantities easily deduced from scale drawings, which avoid use of the sometimes inaccessible refractive index required by Barclay and Le Fèvre's original expression. The applicability of the new equations to the examples previously cited [*ibid.*, 556 (*Feb.*, 1950)], as well as to carbonyl chloride and certain other molecules, is also demonstrated. A.

539.133

2901. Molecular orbital calculations of the lower excited electronic levels of benzene, configuration interaction included. R. G. Parr, D. P. Craig and I. G. Ross. *J. Chem. Phys.*, **18**, 1561–3 (*Dec.*, 1950).

The lower excited π-electron levels of benzene are calculated by the non-empirical method of antisymmetrized products of molecular orbitals (in LCAO approximation) including configuration interaction. All configurations arising from excitation of one or two electrons from the most stable configuration are considered, and all many-centre integrals are retained. The results are in better agreement with experiment and valence-bond calculations than those obtained previously by Craig in a calculation neglecting many-centre integrals. Configuration interaction is found to change the order of the $^1B_{1u}$ and $^1E_{2g}$ states but leave unchanged the order of the $^3B_{1u}$ and $^3B_{2u}$ states, in agreement with the assignments $^1A_{1g}$–$^3B_{1u}$ and $^1A_{1g}$–$^1E_{2g}$ for the experimental bands at 3·8 and 6·2 eV. A.

539.133

2902. The C–Br bond dissociation energy in trichlorobromomethane. M. Szwarc and A. H. Sehon. Letter in *J. Chem. Phys.*, **18**, 1685–6 (*Dec.*, 1950).

539.133 : 532.71

2903. Determination of molecular shape by osmotic measurement. A. Isihara. *J. Chem. Phys.*, **18**, 1446–9 (*Nov.* 15, 1950).

The second coefficient A_2 of osmotic pressure π of high-polymer solutions is calculated in the case of the rigid ovaloid. A_2 is a function of the molecular shape and thus we can determine the shape of high polymers. A.

539.133 : 535.338.334

2904. Pressure broadening of the ammonia inversion line by foreign gases: quadrupole-induced dipole interactions. P. W. Anderson. *Phys. Rev.*, **80**, 511–13 (*Nov.* 15, 1950).

The broadening of the 3,3 line of the inversion spectrum of NH_3 by foreign gases which are not expected to have dipole or quadrupole moments has been measured accurately by Smith and Howard. This broadening is greater than that previously computed by the author using the interaction of the molecule's dipole moment with the induced dipole on the foreign gas atom. In this paper the broadening is explained quantitatively using the interaction of the induced dipole on the foreign gas atom with the quadrupole moment of NH_3. It is concluded that a model of the NH_3 molecule using bond dipoles of the appropriate size to give the known dipole moment, or a model with point charges at the atoms, again adjusted to give the correct dipole moment, both give quadrupole moments which explain the broadening cross-sections with good accuracy. A.

539.133 : 535.343–14

2905. The structure and dipole moment of isothiocyanic acid. C. I. Beard and B. P. Dailey. *J. Chem. Phys.*, **18**, 1437–41 (*Nov.*, 1950).

"Thiocyanic acid" in the vapour state has been found to be at least 95% HNCS. From an analysis of the microwave rotational spectrum the following bond distances and bond angle were determined rH − N = 1·01 Å (assumed), rN − C = 1·218 Å, rC − S = 1·557 Å, H − N − C angle 136°. Analysis of the Stark spectrum indicates that the component of dipole moment along the molecular figure axis is 1·72*D*. Stark components from transitions forbidden in the zero-field spectrum have been observed. A.

539.133 : 535.343–15

2906. The infra-red spectrum and molecular structure of HNCS. L. H. Jones and R. M. Badger. Letter in *J. Chem. Phys.*, **18**, 1511–12 (*Nov.*, 1950).

539.133 : 539.26

2907. The determination of the structures of complex molecules and ions from X-ray diffraction by their solutions: The structures of the groups $PtBr_6^{--}$, $PtCl_6^{--}$, $Nb_6Cl_{12}^{++}$, $Ta_6Br_{12}^{++}$, and $Ta_6Cl_{12}^{++}$. P. A. Vaughan, J. H. Sturdivant and L. Pauling. *J. Amer. Chem. Soc.*, **72**, 5477–86 (*Dec.*, 1950).

A solution of a strongly scattering solute in a weakly scattering solvent yields an X-ray diffraction pattern which closely approximates the diffraction pattern from a gas of the solute molecules. The visual estimation method has been applied to analyse the diffraction patterns from several solutions, and the structures of several complex molecules have thereby been determined. For aqueous chloroplatinic and bromoplatinic acids the diffraction data correspond to an octahedral PtX_6 group. Diffraction patterns from ethanol solutions of $Nb_6Cl_{14}.7H_2O$, $Ta_6Br_{14}.7H_2O$ and $Ta_6Cl_{14}.7H_2O$ are consistent with the assumption of a group M_6X_{12} in which the metal atoms are at the corners of a regular octahedron and the halogen atoms are on the radial perpendicular bisectors of the edges of this octahedron. The shortest interatomic distances in the M_6X_{12} groups are found and agree reasonably well with distances calculated on the basis of Pauling's theory of intermetallic distances. A.

539.133 : 541.62

2908. Note on the rotational isomers of 1, 2-dihalogenoethanes. S. Mizushima and Y. Morino. Letter in *J. Chem. Phys.*, **18**, 1516 (*Nov.*, 1950).

A defence of the rotational isomer theory as an explanation of the Raman and i.r. spectra.

D. H. WHIFFEN

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

2909. Theory of nuclear shells. D. Ivanenko and A. Sokolov. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 33–6 (1950) *In Russian.*

The number of particles with spin ½ and angular momentum in the range δM is given by δN_e in Fermi

statistics. From $\delta N_e = 0$ the number of nucleons is obtained at which a given shell begins to fill. To some regularities of the periodic system a quantum statistical foundation can thus be attributed.

J. JACOBS

539.152.1

2910. A mode of partition of the structure of atomic nuclei. M. A. LEVITSKAYA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 37–40 (1950) *In Russian.*

Nuclei with odd atomic number Z are considered to arise for the corresponding isotope of the preceding even Z by addition of a proton p. Hence isotope tables give the varying law of p-addition; nuclei obeying the same law form a group. The distribution of quadrupole moments of nuclei according to their Z value shows that zeros coincide with ends, maxima with centres, of groups. J. JACOBS

539.152.1

2911. Energy levels of light nuclei. III. W. F. HORNYAK, T. LAURITSEN, P. MORRISON AND W. A. FOWLER. *Rev. Mod. Phys.*, **22**, 291–372 (*Oct.*, 1950).

A review article in which all nuclei from the neutron to Ne^{23} are discussed, superseding earlier work [Abstr. 2516 (1948)]. A level diagram, data on all modes of formation and a short theoretical discussion are given for nearly every nucleus. High energy data is not considered in detail. A table of β-decay constants and a 9-page bibliography is appended.

B. ROSE

539.152.1

2912. Nuclear energy levels, *Z*-11 to 20. D. E. ALBURGER AND E. M. HAFNER. *Rev. Mod. Phys.*, **22**, 373–85 (*Oct.*, 1950).

The data is given in two tables, the first containing the position of the level relative to the ground state (up to 18 MeV-excitation in some cases), the process of formation of the level, the energy release on formation, and references. The second lists the binding energy of the incident particle in certain specific reactions, and certain mass differences.

B. ROSE

539.152.1

2913. Values of μ_p, F, and M_p/m_e using the omegatron. H. SOMMER, H. A. THOMAS AND J. A. HIPPLE. Letter in *Phys. Rev.*, **80**, 487 (*Nov.* 1, 1950).

See also Abstr. 5190 (1950).

539.152.1

2914. On the deviation of nuclear magnetic moments from the Schmidt limits. L. L. FOLDY AND F. J. MILFORD. Letter in *Phys. Rev.*, **80**, 751–3 (*Nov.* 15, 1950).

Mayer's single-particle nuclear model with strong spin-orbit coupling is applied to give a tentative explanation of deviations from the Schmidt limits. It is assumed that there is an exchange of angular momentum between the odd nucleon and the core, in which both the total and the orbital angular momentum of the odd nucleon remain constant in magnitude but not in direction. The exchange is brought about by the polarization effects that the nucleon exerts on the core: surface waves are produced on the latter, which carry angular momentum. In many cases the deviations calculated, in first approximation, on this model are in the right direction and of the correct order of magnitude. Limitations of the model are pointed out. L. PINCHERLE

539.152.1

2915. Observation of nuclear magnetic resonance with a single sweep. G. J. BÉNÉ, P. M. DENIS AND R. C. EXTERMANN. *C.R. Acad. Sci., Paris*, **231**, 1294–5 (*Dec.* 6, 1950) *In French.*

The method has been devised to eliminate the interaction that sometimes occurs between the signal with increasing field and that with decreasing field.

L. PINCHERLE

539.152.1

2916. The possible existence of a constant third-order difference among the nuclear magic numbers. F. A. VALENTE. Letter in *Phys. Rev.*, **80**, 1110 (*Dec.* 15, 1950).

See Abstr. 6008 (1950). Acknowledgment of priority.

539.152.1

2917. Velocity dependent interactions and nuclear shells. C. H. BLANCHARD AND R. AVERY. *Phys. Rev.*, **81**, 35–6 (*Jan.* 1, 1951).

An investigation is made of the energy splitting of the two possible j values, $l \pm \frac{1}{2}$, of a single nucleon outside a closed shell resulting from the assumption of certain velocity-dependent terms in the nucleon-nucleon interaction. See Abstr. 6263 (1950). A.

539.152.1

2918. Two-body nuclear interaction, consistent, within the limits of a single configuration, with the spin and magnetic moment of the ground-states of lithium-6, boron-10 and lithium-7. J. P. ELLIOTT AND H. A. JAHN. Letter in *Nature, Lond.*, **167**, 32–3 (*Jan.* 6, 1951).

539.152.1

2919. Theoretical studies in nuclear structure. II. Nuclear d^2, d^3 and d^4 configurations. Fractional parentage coefficients and central force matrix elements. H. A. JAHN. *Proc. Roy. Soc. A*, **205**, 192–237 (*Feb.* 7, 1951).

The orbital and charge-spin fractional parentage coefficients for the nuclear d^3 and d^4 configurations are derived using group theory. The orbital coefficients are given in a form appropriate to the new subclassification of the states according to irreducible representations of R_5 discussed in part I [Abstr. 6009 (1950)]. Using these coefficients the complete energy matrices for the d^3 and d^4 configurations are derived, for a general charge-symmetric central two-body interaction, from the known energy matrix for the d^2 configuration. A.

539.152.1

2920. Theoretical studies in nuclear structure. III. Radial integrals for the nuclear *s*, *p* and *d* shells. W. J. SWIATECKI. *Proc. Roy. Soc. A*, **205**, 238–46 (*Feb.* 7, 1951).

In working out nuclear energy levels on the Hartree approximation one meets certain integrals involving the interaction potential and the particle radial wave-functions [see Abstr. 6009 (1950) and preceding Abstr.]. In this note these integrals are defined and worked out for the $1s$, $2p$, $3d$ wave-functions of a 3-dimensional oscillator using as interaction potential (*a*) the Gauss potential, (*b*) the meson potential. A.

539.152.1 : 539.172.4

2921. On the probability of asymmetric and symmetric fission. T. YASAKI AND O. MIYATAKE. Letter in *Phys. Rev.*, **80**, 754–5 (*Nov.* 15, 1950).

The experimentally observed ratio is explained by a special type of nuclear shell model. The usual neutron shells exist, at the "magic numbers" 2, 8, 20, 50, 82, 126, but the protons are arranged in a shell of 27 attached to the neutron 50-shell, with the remainder distributed uniformly in the outer part of the nucleus. J. HUGHES

539.152.2

2922. Spin echoes. E. L. HAHN. *Phys. Rev.*, **80**, 580–94 (*Nov.* 15, 1950).

Intense radiofrequency power in the form of pulses is applied to an ensemble of spins in a liquid placed in a large static magnetic field H_0. The frequency of the pulsed r.f. power satisfies the condition for nuclear magnetic resonance, and the pulses last for times which are short compared with the time in which the nutating macroscopic magnetic moment of the entire spin ensemble can decay. After removal of the pulses a non-equilibrium configuration of isochromatic macroscopic moments remains in which the moment vectors precess freely. Each moment vector has a magnitude at a given precession frequency which is determined by the distribution of Larmor frequencies imposed upon the ensemble by inhomogeneities in H_0. At times determined by pulse sequences applied in the past the constructive interference of these moment vectors gives rise to observable spontaneous nuclear induction signals. The properties and underlying principles of these spin echo signals are discussed with use of the Bloch theory. Relaxation times are measured directly and accurately from the measurement of echo amplitudes. An analysis includes the effect on relaxation measurements of the self-diffusion of liquid molecules which contain resonant nuclei. Preliminary studies are made of several effects associated with spin echoes, including the observed shifts in magnetic resonance frequency of spins due to magnetic shielding of nuclei contained in molecules. A.

539.152.2

2923. Nuclear magnetic moment of S^{33}. J. R. ESHBACH, R. E. HILLGER AND C. K. JEN. Letter in *Phys. Rev.*, **80**, 1106–7 (*Dec.* 15, 1950).

539.152.2

2924. On the nuclear magnetic moments of several stable isotopes. W. G. PROCTOR AND F. C. YU. *Phys. Rev.*, **81**, 20–30 (*Jan.* 1, 1951).

The nuclear-induction spectrometer previously described [Abstr. 8167 (1950)] was used to measure the magnetic moments of a number of nuclei. These values are without corrections of any kind and are based upon a value for the magnetic moment of the proton of $(2{\cdot}79348 \pm 0{\cdot}00034)$ nuclear magnetons. Observation of a large variety of nuclei has made it possible to discuss in a general way the selection of a suitable sample compound. Phenomena discussed are: dependence of nuclear resonance frequencies on the compound used for the sample in some cases, an effect of molecular rather than nuclear origin; the magnetic moments of both In^{113} and In^{115} have been found to be 0·64% greater than their respective atomic beam values, a discrepancy very similar to that noted for Ga^{69} and Ga^{71}; an h.f.s anomaly for the isotopes of Cl has been observed, which is notable, because the atomic beam experiments deal with the $P_{3/2}$ state of atomic Cl; an unusual structure for the Sb^{121} and Sb^{123} resonances in aqueous solution of $NaSbF_6$ has been observed and is qualitatively explained. A.

539.152.2 : 530.145

2925. On the quantization of angular momenta in heavy nuclei. A. BOHR. *Phys. Rev.*, **81**, 134–8 (*Jan.* 1, 1951).

The individual particle model of nuclear structure fails to account for the observed large nuclear quadrupole moments. It is possible, however, to allow for the existence of the quadrupole moments, and still retain the essential features of the individual particle model, by assuming the average field in which the nucleons move to deviate from spherical symmetry. The assumptions underlying such an asymmetric nuclear model are discussed; this model implies, in particular, a quantization of angular momenta in analogy with molecular structure. The asymmetric model appears to account better than the extreme single-particle model for empirical data regarding nuclear magnetic moments. A.

539.152.2 : 535.338.332

2926. On the tritium hfs and the anomalous magnetic moment of the triton. E. N. ADAMS, II. *Phys. Rev.*, **81**, 1–7 (*Jan.* 1, 1951).

The h.f.s of T is studied using the model of A. Bohr according to which the electron centres on the proton at small electron-nuclear separations. The h.f.s effects due to this recentring of the electron are calculated for 3 theories of the origin of the triton moment anomaly: the spin-orbital moment theory of Avery and Sachs, the phenomenological interaction moment theory of Blanchard, Avery and Sachs, and the meson exchange moment theory of Villars. In addition the h.f.s contributions due to relativistic effects of internal nuclear motion are calculated for D, and the result is used to estimate the uncertainty in the T h.f.s coming from this source. It is found that in each case considered the h.f.s effects may be classified as either "Bohr effect," proportional to the size of the nucleus, or "orbital effect," proportional to the size of the region of centring of the electron. On each of the 3 theories the total h.f.s effect is of the order of magnitude of the present experimental uncertainty in the determination of the T h.f.s. While the effect is large enough to be observed with only a small improvement of the experimental precision, it is about the same for each theory considered and would not, therefore, serve as a means of distinguishing among the several theoretical accounts of the triton moment anomaly. A.

539.152.2 : 539.181

2927. An atomic beam source and spectrograph for hyperfine structure. Nuclear moments of silver. M. F. CRAWFORD, A. L. SCHAWLOW, F. M. KELLY AND W. M. GRAY. *Canad. J. Res. A*, **28**, 558–73 (*Nov.*, 1950).

An atomic beam source and a fast spectrograph which have been used effectively in hyperfine structure

investigations are described. The camera objective of the spectrograph is an off-axis paraboloidal mirror. The procedures used to determine the nuclear moments of the 2 Ag isotopes, $I = \frac{1}{2}$ for each isotope, $\mu(Ag^{107}) = -0{\cdot}087$ n.m. and $\mu(Ag^{109}) = -0{\cdot}160$ n.m., are reported. A.

539.153

2928. Wave functions and transition probabilities for the Mg I atom. III. The influence of polarization. E. Trefftz. *Z. Astrophys.*, **28** (*No.* 1) 67–78 (1950) *In German.*

See Abstr. 5203–4 (1950) for previous parts. Earlier calculations are extended. Wave functions, dipole moments and transition probabilities are tabulated, and calculated oscillator strengths are compared with observational results. R. A. NEWING

539.153

2929. Experimental determination of the life-times of atomic resonance state. G. Stephenson. Letter in *Nature, Lond.*, **167,** 112 (*Jan.* 20, 1951).

539.153

2930. Life-time of the lithium atomic resonance states. G. Stephenson. Letter in *Nature, Lond.*, **167,** 156 (*Jan.* 27, 1951).

The total absorption method, which involves the integral of the absorption coefficient over the whole absorption line, has been applied to the $(2^2S_{1/2}–2^2P)$ (λ6708 Å) transition of Li. It gives an *f*-value of $0{\cdot}72 \pm 0{\cdot}03$, corresponding to a life-time of $2{\cdot}8 \times 10^{-8}$ sec for the resonance states, in good agreement with theoretical values. L. PINCHERLE

539.153.4 : 535.342

2931. The continuous radiative absorption cross-section of singly ionized potassium. M. J. Seaton. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 3) 247–55 (1950).

After obtaining exchange wave functions of K III the continuous absorption cross-section of K II is calculated over the energy range 0 to 13·53 eV of the ejected electron, using both the dipole length and the dipole velocity formulae and allowing for the effect of electron exchange. The recommended mean value is taken to be $\alpha_\nu = 3{\cdot}2 \times 10^{-17} \nu_1/\nu$ cm², where ν_1 is the frequency at the spectral head. The cross-section data are used to evaluate the "modified dilution factor" introduced by Strömgren in considering the ionization balance in interstellar space. The possibility of captures to excited states introduces a correction factor of 430 ($T_e = 10^2$), 290 ($T_e = 10^3$), 160 ($T_e = 10^4$), where T_e is the electron temperature (deg K). The abundance of interstellar K is briefly discussed. A.

539.155

2932. Mass spectra of some simple isotopic molecules. V. H. Dibeler, F. L. Mohler, E. J. Wells, Jr. and R. M. Reese. *J. Res. Nat. Bur. Stand., Wash.*, **45,** 288–91 (*Oct.*, 1950).

The mass spectra of H_2, D_2, T_2, HD and HT have been measured with a mass spectrometer with 50 V ionizing voltage and with a constant magnetic field. The following ratios of atom ions to molecule ions were observed: $H^+/H_2^+ = 0{\cdot}0201$, $D^+/D_2^+ = 0{\cdot}0096$, $T^+/T_2^+ = 0{\cdot}0061$, $H^+/HD^+ = 0{\cdot}0096$, $D^+/HD^+ = 0{\cdot}0097$, $H^+/HT^+ = 0{\cdot}0085$, and $T^+/HT^+ = 0{\cdot}0068$. The ratios for T_2 and HT were derived from spectra of two samples containing 91 and 37 atomic % of T in equilibrium with H. Theoretical values for the ratios were computed for ionization involving transition into the Σ_g state of the molecule ion. These values are lower than the observed ratios, because transitions to higher repulsive states contribute to the observed values at 50 V ionizing voltage. Mass spectra of CO and CO_2 containing about 54 atom % C^{13} were measured under standard operating conditions. For CO the ratio $C^{12+}/C^{12}O^+ = 0{\cdot}0540$ and $C^{13+}/C^{13}O^+ = 0{\cdot}0514$. For CO_2, the ratios are $C^{12}O^+/C^{12}O_2^+ = 0{\cdot}0868$, $C^{13}O^+/C^{13}O_2^+ = 0{\cdot}0824$, $C^{12+}/C^{12}O^+ = 0{\cdot}0564$, and $C^{13+}/C^{13}O_2^+ = 0{\cdot}0542$. A theory of the isotope effect in CO involving simplifying assumptions indicates that the relative probability of producing C^{12+} is 3·5% greater than the probability of producing C^{13+}, as compared with an observed difference of 5%. A.

539.155.1/.4 : 539.167.3

2933. Mass-spectrographic identification of Cm^{243} and Cm^{244}. F. L. Reynolds, E. K. Hulet and K. Street, Jr. Letter in *Phys. Rev.*, **80,** 467 (*Nov.* 1, 1950).

539.155.2

2934. The effect of isotopic substitution on mass spectra of molecules. O. A. Schaeffer. *J. Chem. Phys.*, **18,** 1501–5 (*Nov.*, 1950).

A general method for calculating the effect of isotopic substitution on mass spectra is presented. The calculation is based on the notion that the various fragment ions, formed by electron impact on a molecule, are produced by a Franck–Condon mechanism. It is assumed that those bonds will break which possess more potential energy than bond energy at the instant of ionization. The mass spectral data for a molecule are used in conjunction with the ground-state vibrational wave function to evaluate critical bond distances (distances for which the potential energy equals the bond energy). Then the mass spectral pattern for isotopic molecules can be predicted from a knowledge of the ground-state vibrational wave function of the isotopic molecule. The method is applied to the diatomic molecules $N^{14}N^{14}$, $N^{14}N^{15}$, $N^{15}N^{15}$ and $C^{12}O^{16}$, $C^{13}O^{16}$. The predicted values compare favourably with previously observed results; however, experimental errors obscure a sharp test of the predictions for these cases. New experimental values are presented for the ratios $C^{13+}/C^{13}O_2^{16+}$ and $C^{12+}/C^{12}O_2^{16+}$ from carbon dioxide and compared with predictions. Good agreement is found between ratios extrapolated to high ion accelerating voltage and predicted ones. A.

539.155.2

2935. World-wide distribution of natural radiocarbon. E. C. Anderson and W. F. Libby. *Phys. Rev.*, **81,** 64–9 (*Jan.* 1, 1951).

The natural radiocarbon content of biological materials collected from widely-scattered locations have shown no evidence of the latitudinal variation to be expected were the turnover time for the biosphere comparable with the mean life of radiocarbon. The strong dependence of the intensity of the cosmic-ray neutrons on latitude would be expected to cause this

effect. Since it is expected, however, that the turnover time for the biosphere would be relatively very short, the observed uniformity is not surprising. The observed mean assay of C in equilibrium with the biosphere is $16{\cdot}1 \pm 0{\cdot}5$ dpm/g C. Consideration of the amounts of the various types of C in equilibrium with the biosphere gives $8{\cdot}3$ grams per cm² of the earth's surface. From a direct comparison with observed cosmic-ray neutron intensity the mean specific activity of C in equilibrium with the biosphere would be expected to be the ratio of 156 to $8{\cdot}3$, or $18{\cdot}8 \pm 5$ dpm/g. The agreement between the predicted and observed specific activity, owing to the considerable uncertainties in our knowledge of the cosmic-ray intensity and the amount of diluting C, may be somewhat fortuitous. It does appear to indicate, however, that no considerable variation in cosmic-ray intensity over the past several thousand years has occurred. The fact that the principal part of the diluting reservoir is inorganic material in the sea water serves to make any large variation in the amount of C in this reservoir unlikely. A.

539.155.2 : 539.163.2 : 539.172.13

Concentration of A^{36} and A^{38}. *See Abstr.* 3012

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

2936. A method for determining uranium and thorium in rocks by the nuclear photographic plate. J. W. BREMNER. *Proc. Phys. Soc., Lond., A*, **64**, 25–31 (*Jan.*, 1951).

A nuclear photographic emulsion which has been in contact with material containing traces of uranium and thorium shows on processing α-ray stars arising from atoms which have undergone several successive disintegrations during the exposure. The relative frequency of the various multiple stars, which depends on the uranium/thorium ratio, is here evaluated on simple assumptions to show the possibility of determining these elements by star counting. A.

539.162

2937. Statistics of the life-times of atomic nuclei and the stability of natural elements. A. V. TROFIMOV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 45–8 (1950) *In Russian.*

Graphs are given of numbers of isotopes, from Mattauch's "Isotopenbericht" (1949), plotted against $\log \tau$ ($\frac{1}{2}$-period), for all modes of spontaneous decay and for each mode separately. By extrapolating the curves to $\tau = 10^{22}$ years, it is concluded that $\not> \sim 5$ "stable" isotopes, of the > 250 known, are weakly β-active and $\not> \sim 10$ weakly α-active.

J. C. E. JENNINGS

539.163

2938. Nuclear data. K. WAY, L. FANO, M. R. SCOTT AND K. THEW. *Circ. Nat. Bur. Stand., Wash., No.* 499, 309 *pp.* (1950).

A collection of experimental values of half-lives, radiation energies, relative isotopic abundances, nuclear moments and cross-sections. Closing date was Jan. 1, 1950, but some data published in 1950 are included. The data for each element are presented on separate sheets facilitating entry of additional matter and interpolating future supplementary sheets. References are given for all data quoted.

539.163

2939. The decay of Sb^{120}. J. P. BLASER, F. BOEHM AND P. MARMIER. *Helv. Phys. Acta*, **23** (*No.* 6–7) 623–6 (1950) *In German.*

Sb^{120} decays by emission of a positron spectrum with upper limit of 1·70 MeV and by *K*-capture. Three γ-rays with energies of 0·90, 1·30 and 2·20 MeV are present. The probable disintegration-scheme is given. A.

539.163

2940. Experiments on the angular correlation of successive nuclear radiations. M. WALTER, O. HUBER AND W. ZÜNTI. *Helv. Phys. Acta*, **23** (*No.* 6–7) 697–730 (1950) *In German.*

Some experimental questions of a general nature which arise in the measurement of angular correlations are discussed. In particular the effect of the finite aperture of the recording instruments is evaluated. Results of experiments are also given: in β–γ coincidences in Mn^{56} and Au^{198} isotropic distributions were found, whilst for As^{76} and for the distribution of successive conversion electrons from Hg^{197} an anisotropy with $\frac{W\pi - W\pi/2}{W\pi/2} = 0{\cdot}08 \pm 0{\cdot}02$ and $0{\cdot}24 \pm 0{\cdot}03$ respectively were found. W. J. SWIATECKI

539.163

2941. Short-lived isomers of Ta^{181}. W. C. BARBER. *Phys. Rev.*, **80**, 332–7 (*Nov.* 1, 1950).

Excited states of Ta^{181} which result from the 46-day β-decay of Hf^{181} were investigated by the method of delayed coincidences. Using *trans*-stilbene scintillation counters and a coincidence system of about $1{\cdot}3 \times 10^{-8}$ sec resolving time, a state with a half-life of $(1{\cdot}08 \pm 0{\cdot}05) \times 10^{-8}$ sec was observed. Delayed coincidence absorption experiments indicated that the radiation following the delayed state arises chiefly from a transition of about 0·5 MeV energy. The radiations preceding and following the $2{\cdot}2 \times 10^{-5}$ sec state were also investigated and, in agreement with other recent results, no γ-rays were observed in the preceding radiation. Possible assignments of spin and parity to the excited states of the Ta^{181} nucleus are discussed. The scintillation counter system was also used to search for delayed coincidences in the radiations following the decay of other isotopes. Sources of 5·3 yr Co^{60}, 225 day Ag^{110}, 2·7 day Au^{198}, 2·6 hr Mn^{56} and 34 hr Br^{82} gave negative results. The 8×10^{-8} sec state of Cd^{111} was observed in the decay of 2·8 day In^{111}. A.

539.163

2942. Radioactive isotopes of rubidium. D. G. KARRAKER AND D. H. TEMPLETON. *Phys. Rev.*, **80**, 646–50 (*Nov.* 15, 1950).

Neutron-deficient isotopes of Rb have been prepared from Br by bombardment with He ions in the Berkeley 184 in and 60 in cyclotrons. The properties of the isotopes Rb^{81-4} are given: The mass numbers

were determined with a mass spectrograph. Rb^{81} has been shown to decay to the 13 sec Kr, thereby assigning it to Kr^{81}. Electrons from the conversion of a 190 KeV gamma-ray caused by this Kr are observed with the Rb^{81} radiations. A.

539.163

2943. The disintegration of praseodymium 142. E. N. Jensen, L. J. Laslett and D. J. Zaffarano. *Phys. Rev.*, **80**, 862–5 (*Dec.* 1, 1950).

The radiations from Pr^{142} have been examined with a thin-lens spectrometer. One gamma-ray was found having an energy of $1{\cdot}57_6$ MeV. The beta-spectrum is complex, the two groups observed having maximum kinetic energies of $2{\cdot}15_4$ MeV and $0{\cdot}63_6$ MeV. It is suggested that the high-energy beta-group gives a transition to the ground state of Nd^{142} and that the gamma-ray follows the low-energy beta-transition. The half-life was found to be 19·1 hr. The electron distribution produced by bremsstrahlung, due to the absorption of the beta-rays, was observed. A.

539.163

2944. On the radioactivity of potassium. M. Ceccarelli, G. Quareni and A. Rostagni. Letter in *Phys. Rev.*, **80**, 909–10 (*Dec.* 1, 1950).

539.163

2945. The natural radioactivity of In^{115}. E. A. Martell and W. F. Libby. *Phys. Rev.*, **80**, 977–82 (*Dec.* 15, 1950).

An investigation of the possible natural radioactivities of the Cd^{113}–In^{113} and In^{115}–Sn^{115} pairs of adjacent isobars gave evidence for a natural beta-radioactivity of In. Four samples of In differing in geographical origin were subjected to radiochemical purification and then examined in a screen wall counter arranged with anticoincidence counters and steel shielding. Absorption measurements on these samples gave reproducible results indicative of an energetic natural beta-radiation. The energy was measured by comparing the absorption characteristics of the In radiation with those of Tl^{204} and Co^{60}, whose beta-energies have been measured spectroscopically. Measurement of isotopically enriched samples of In gave conclusive evidence that the origin of the beta-radiation is the In^{115} isotope. Limits were placed on possible accompanying gamma-radiation. The results indicate that In^{115} emits a natural beta-radiation of $0{\cdot}63 \pm 0{\cdot}03$-MeV energy with a half-life of $6 \pm 2 \times 10^{14}$ years. A.

539.163

2946. A precise determination of the half-life and average energy of tritium decay. G. H. Jenks, F. H. Sweeton and J. A. Ghormley. *Phys. Rev.*, **80**, 990–5 (*Dec.* 15, 1950).

A precise determination of the half-life of T and of the average energy released by the decay has been carried out. The half-life was determined from measurements of the quantity of T contained in a sample and the rate at which that quantity gave rise to He^3. The average energy release was determined from additional measurements on the same sample of the rate at which the sample liberated heat. The value found for the half-life was $12{\cdot}46 \pm 0{\cdot}1$ years. That found for the average energy released by decay of neutral T to neutral He was $5{\cdot}69 \pm 0{\cdot}04$ keV. A.

539.163

2947. Radioactivity of F^{17}. V. Perez-Mendez and P. Lindenfeld. Letter in *Phys. Rev.*, **80**, 1097–8 (*Dec.* 15, 1950).

539.163

2948. New neutron-deficient radioactive isotopes of the light rare-earth region. B. J. Stover. *Phys. Rev.*, **81**, 8–13 (*Jan.* 1, 1951).

In the light rare-earth region, 7 new neutron-deficient radioactive isotopes have been produced by proton bombardment in the 184 in cyclotron and the linear accelerator; their radiations have been studied by absorption-curve and magnetic-counter methods. The new isotopes and their half-lives are La^{134}, $6{\cdot}5 \pm 0{\cdot}25$ min; Ce^{133}, $6{\cdot}30 \pm 0{\cdot}1$ hr; Ce^{134}, $72{\cdot}0 \pm 0{\cdot}5$ hr; Pr^{138}, 120 ± 5 min; Pr^{139}, $4{\cdot}50 \pm 0{\cdot}2$ hr; Nd^{138}, 22 ± 2 min; Nd^{139}, $5{\cdot}50 \pm 0{\cdot}2$ hr. Additional data have been obtained for the isotopes, Ce^{135} and Ce^{137}. A.

539.163 : 539.154.2

2949. The new element berkelium (atomic number 97). S. G. Thompson, A. Ghiorso and G. T. Seaborg. *Phys. Rev.*, **80**, 781–9 (*Dec.* 1, 1950).

An isotope of the element with atomic number 97 has been discovered as a product of the He-ion bombardment of Am. This isotope decays with the emission of alpha-particles of maximum energy 6·72 MeV (30%) and it emits lower energy alpha-particles of energies 6·55 MeV (53%) and 6·20 MeV (17%). The half-life of this isotope is $4{\cdot}6 \pm 0{\cdot}2$ hr and it decays primarily by electron capture with about 0·1% branching decay by alpha-particle emission. The mass number is probably 243 as indicated by chemical separation of the alpha-particle and electron-capture daughters. The chemical separation of element 97 from the target material and other reaction products was made by combinations of precipitation and ion-exchange adsorption methods making use of its anticipated (III) and (IV) oxidation states and its position as a member of the actinide transition series. The distinctive chemical properties made use of in its separation and the equally distinctive decay properties of the particular isotope constitute the principal evidence for the new element. The isotope Cm^{243} is identified experimentally as a result of its production as a decay product of Bk^{243}. The Cm^{243} decays by the emission of alpha-particles of maximum energy 5·89 MeV (15%) and lower energy alpha-particles of energy 5·79 MeV (85%); the half-life for alpha-particle emission is estimated to be roughly 100 yr. A.

539.163 : 539.154.2

2950. The new element californium (atomic number 98). S. G. Thompson, K. Street, Jr., A. Ghiorso and G. T. Seaborg. *Phys. Rev.*, **80**, 790–6 (*Dec.* 1, 1951).

Definite identification has been made of an isotope of the element with atomic number 98 through the irradiation of Cm^{242} with about 35 MeV He ions in a 60 in cyclotron. The isotope which has been identified has an observed half-life of about 45 min

and is thought to have the mass number 244. The observed mode of decay of 98[244] is through the emission of alpha-particles, with energy of about 7·1 MeV, which agrees with predictions. Other considerations involving the systematics of radioactivity in this region indicate that it should also be unstable toward decay by electron capture. The chemical separation and identification of the new element was accomplished through the use of ion-exchange adsorption methods employing the resin Dowex-50. The element 98 isotope appears in the eka-Dy position on elution curves containing Bk and Cm as reference points—that is, it precedes Bk and Cm off the column in like manner that Dy precedes Tb and Gd. The experiments so far have revealed only the tripositive oxidation state of eka-Dy character and suggest either that higher oxidation states are not stable in aqueous solutions or that the rates of oxidation are slow. The successful identification of so small an amount of an isotope of element 98 was possible only through having made accurate predictions of the chemical and radioactive properties. A.

539.163 : 539.154.2

2951. Elements 97 and 98. A. P. Znoĭko and V. I. Semishin. *Dokl. Akad. Nauk, SSSR*, 74 (*No.* 5) 917–19 (1950) *In Russian.*

The radioactivities of some of their isotopes were predicted from a periodic law [Abstr. 5210 (1950)]. 97[243] or 97[244] [Abstr. 6020 (1950)] conformed and so did 98[244] [Abstr. 6692 (1950)]. Probable periods and modes of decay are given for 11 isotopes of 97 and for 9 of 98. Since the periodic law enabled properties of 97 to be predicted 2 years before its isolation, the name mendelevium (Md) is proposed.

J. C. E. JENNINGS

539.163 : 539.154.2

2952. The natural system of atomic nuclei and the problem of element 61. N. A. Novosei skaya. *Dokl. Akad. Nauk, SSSR*, 74 (*No.* 5) 921–3 (1950) *In Russian.*

On the basis of Znoĭko's periodic system [Abstr. 3331–2, 5210 (1950)] it is concluded that 61[145] should be α-active with a ½-period of 10^7–10^9 years, i.e. of the order of the age of the earth. It should probably be found naturally in small concentrations mixed with Sm. J. C. E. JENNINGS

539.163.1

2953. Half-life of Cu[66]. A. G. W. Cameron and L. Katz. Letter in *Phys. Rev.*, **80**, 904 (*Dec.* 1, 1950).

539.163.1

2954. On the half-life of actinium. J. M. Hollander and R. F. Leininger. Letter in *Phys. Rev.*, **80**, 915–16 (*Dec.* 1, 1950).

539.163.1

2955. The precision determination of some half-lives. J. W. Cobble and R. W. Atteberry. Letter in *Phys. Rev.*, **80**, 917 (*Dec.* 1, 1950).

Results are given for Na[24], Cl[38], Br[82] and Tc[96].

539.163.1

2956. A $1{\cdot}7\times10^{-9}$-sec. isomeric state in $_{68}$Er[166]. F. K. McGowan. Letter in *Phys. Rev.*, **80**, 923–4 (*Dec.* 1, 1950).

539.163.1

2957. Measurements of short-lived isomers. W. J. MacIntyre. *Phys. Rev.*, **80**, 1018–23 (*Dec.* 15, 1950).

The half-lives of 8 short-lived isomers were investigated by the delayed coincidence method of detecting short-lived excited gamma-states following beta-emission. Of these, the half-life of Hg[198]* following beta-decay of Au[198] was measured as $2{\cdot}3\times10^{-8}$ sec. Excited states of Mg[24]*, Hg[199]*, Ca[42]*, Nd[142]*, A[38]*, Te[122]* and Fe[56]* were found to have half-lives shorter than 1 to 2×10^{-8} sec, the lowest value measurable, owing to circuit limitations. By means of the measured half-lives or upper limits, probable l values, the change in units of angular momentum, were assigned through comparison with the theoretical values of the Segrè–Helmholz formula. Correlation with l values estimated through other methods has resulted in probable assignment of l values for 4 isomers and upper l values for the remaining 4. A.

539.163.1

2958. Half-life of bromine-82. F. P. W. Wintering-ham. Letter in *Nature, Lond.*, **167**, 155 (*Jan.* 27, 1951).

539.163.2

2959. The radioactivity of Ga[66]. L. M. Langer and R. D. Moffat. *Phys. Rev.*, **80**, 651–4 (*Nov.* 15, 1950).

The disintegration of Ga[66] results in 4 positron groups with end-point energies and relative intensities of 4·144 MeV, 87%; 1·4 MeV, 4·3%; 0·878 MeV, 6·9%; and 0·403 MeV, 1·7%. Nuclear gamma-rays having energies of 1·03 MeV, 2·75 MeV and 4·8 MeV are observed. Measurement of the associated Auger electrons at 7·3 keV indicates that 34% of all disintegrations are by K-electron capture. The 4·14 MeV positron spectrum is found to have a shape characteristic of an allowed transition. In consideration of its high ft-value, it is therefore inferred that this transition is once forbidden with a change of parity and a spin change of 0 or 1 unit. Furthermore, this transition does not go to the ground state of Zn[66], but rather appears to be followed by the 1·03 MeV gamma-ray. The direct 5·17 MeV transition between ground states is found to proceed in less than 0·4% of the positron decays. This transition is apparently twice forbidden with a spin change of 3 units and is effectively outcompeted by the other less forbidden modes of decay. A.

539.163.2

2960. Decay of Y[87] and Sr[87m]. L. G. Mann and P. Axel. Letter in *Phys. Rev.*, **80**, 759 (*Nov.* 15, 1950).

539.163.4

2961. The efficiency of a uranium-X-separation method. J. B. T. Aten and F. Barendregt. *Physica*, **16**, 760–6 (*Oct.*, 1950).

By means of a G.M. counter for radioactive fluids the efficiency of the separation of UX was determined. The efficiency for the ether-water separation method proved to be about 95%, that of the ammonium–carbonate/iron method about 70%. Removal of the iron with NH_4SCN and ether gave a loss of UX of about 5·5%. To avoid adsorption of UX to the glass the glassware was treated with concentrated HCl. Some indications for the preparation of a carrier-free UX source on mica are given. A.

539.164 : 539.166

2962. Angular correlation of α-particles and γ-quanta emitted in cascade. A. Z. Dolginov. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1149–51 (1950) *In Russian.*

Perturbation theory is inapplicable because the interaction between α-particle and the nucleus is of the same order as the energy of the emitted α-particle. The method of Yang [Abstr. 1158 (1949)] for angular distribution in nuclear reactions is therefore applied. An expression is given for the angular distribution of γ-radiation from a 2^l-pole γ-radiator, with respect to the direction of the preceding α-particle. To evaluate this, Preston's [*Phys. Rev.*, **71**, 865 (1948)] calculation of the probability of emission of an α-particle of given momentum may be used. Kulchitskiĭ's result (see Abstr. following) that there is a strong correlation is sufficient evidence that Ellis and Mott [*Proc. Roy. Soc. A*, **139**, 369 (1933)] and Oppenheimer [*Proc. Camb. Phil. Soc.*, **32**, 328 (1936)] were wrong regarding the angular momenta of the levels of ThC and ThC″ concerned. An expression is also given for the probability of γ-emission as a function not only of direction of emission but also of polarization with respect to the α-particle's direction. J. C. E. JENNINGS

539.164 : 539.166

2963. The relation between the directions of emission of α-particles and γ-quanta in the transition ThC → ThC″. L. A. Kulchitskiĭ. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1153–6 (1950) *In Russian.*

Th on a 5 μ thick Al foil was placed in a chamber in which the gas pressure sufficed to absorb slower α-groups from ThC, those measured corresponding to the transition to the first excited level of ThC″. The α-particles were detected by a proportional counter, the γ-quanta by a counter protected from β-rays by a filter. Coincidences were registered by means of a Rossi circuit. A maximum γ-emission near to 45° shows that the γ-radiation cannot be dipole (see preceding Abstr.). Of quadrupole possibilities, the closest agreement is for spins 0, 3, 1 of the initial, intermediate and final nuclear states respectively; but it is unlikely that an odd-even nucleus in the ground state should have spin 0. An alternative possibility, agreeing well with the results, is that the first excited level consists of 2 states, close together in energy and with spins 2 and 3.

J. C. E. JENNINGS

539.164.2

2964. On a linear property common to all α-emitting elements of the natural families. C. Martin. *C.R. Acad. Sci., Paris*, **231**, 1467–8 (*Dec.* 18, 1950) *In French.*

A simple relation is found to exist between the decay constant of an element and the number $U = 3A/4 - Z$, where A is the mass number and Z is the atomic number. A graph shows the breakdown of the relation for nuclei with closed shells of 82 protons and 126 neutrons. J. HUGHES

539.164.74

2965. The theory of the anomalous scattering of α-particles by spinless nuclei. H. Marschall. *Z. Phys.*, **128** (*No.* 5) 635–56 (1950) *In German.*

Investigated for the case when one of the partial waves composing the impinging α-particles is at resonance and the nucleus is assumed impenetrable for all other partial waves. The ratio of the anomalous to the pure Rutherford differential cross-section is calculated (using the W.K.B. method throughout). The anomaly is found to be due to two causes: one associated with the appearance of resonance and the other with the modification of the non-resonant partial waves due to the finite radius of the nucleus. For α-particle energies less than the Gamow barrier the former is found to be more important. A detailed comparison of the two effects is made for the O^{16} nucleus. W. J. SWIATECKI

539.165

2966. The beta-radiations of UX_1 and UX_2. M. Heerschap, Ong Ping Hok and G. J. Sizoo. *Physica*, **16**, 767–80 (*Oct.*, 1950).

The complete beta-spectrum of $U(X_1 + X_2)$ was measured with a 180° spectrometer. The primary spectrum of UX_1 proved to be decomposable into 2 components with endpoints at 192 and 104 keV and intensities 56% and 44%. That of UX_2 showed 3 components with endpoints at 2 320, 1 500 and 600 keV, the intensities being 80%, 13% and 7%. The reality of the 600 keV component, however, is considered as dubious. The secondary spectrum of UX_1 shows 3 lines which could be explained by conversion of a 90·4 keV nuclear gamma-ray in the L_I, M_I and N_I-shell. That of UX_2 consists of 2 lines, arising by conversion of a 817 keV nuclear gamma-ray in the K and L_I-shell. As far as concerns the values of the energies the results are in good mutual agreement. Serious discrepancies remain between the intensities of the gamma-ray derived from the beta-spectra and those determined by absorption measurements. A.

539.165

2967. The Ca^{45} beta-distribution obtained in a split crystal scintillation spectrometer. B. H. Ketelle. Letter in *Phys. Rev.*, **80**, 758–9 (*Nov.* 15, 1950).

539.165

2968. Beta-decay of isomeric Cd^{113}. W. L. Carss, J. R. Gum and M. L. Pool. *Phys. Rev.*, **80**, 1028–9 (*Dec.* 15, 1950).

A 5·1 ± 0·3 yr activity has been assigned as an isomer of the stable Cd^{113} isotope. Instead of the usual decay to the ground state by gamma-rays, beta-rays of 0·5 MeV are emitted to form In^{113}. X-rays are also observed. A.

539.165

2969. Abnormal radiation accompanying β-disintegrations. J. Thibaud. *C.R. Acad. Sci., Paris*, **231**, 1469–71 (*Dec.* 18, 1950) *In French.*

Certain traces on photographic plates exposed in a spectrograph with an inhomogeneous magnetic field [Abstr. 7067 (1949)] are now ascribed to negative particles of electronic charge and very high $H\rho$ ($\sim 2 \times 10^4$ gauss-cm). B. ROSE

539.165

2970. A note concerning the C^{14}–N^{14} β-decay. E. Gerjuoy. *Phys. Rev.*, **81**, 62–3 (*Jan.* 1, 1951).

The possibility that the parities of the ground states of C^{14} and N^{14} are opposite is discussed. Experiments which would determine or assist in determining the parity change are suggested. A.

539.165 : 537.533.74/.75

Transmission of beta-rays by nylon and formvar. *See Abstr.* 2748

539.165 : 537.533.74/.75

2971. Self-absorption and backscattering of β-radiation. L. E. GLENDENIN AND A. K. SOLOMON. *Science*, **112**, 623–6 (*Nov.* 24, 1950).

S^{35}, Ca^{45} and P^{32} beta-emitters were examined in a 1·5 mg/cm² end-window counter subtending 25% and 9% solid angles for two source positions. The observed specific activity of Ca^{45} in $CaCO_3$ evaporated on to thick Al, Cu and steel dishes, was found to vary with source thickness in accordance with an exponential law of absorption with $\mu = 0{\cdot}09$ cm²/g in each case. S^{35} beta-rays in benzidene sulphate source materials were absorbed with a value of $\mu = 0{\cdot}18$ cm²/gm. The saturation backscattering (i.e. with thick backing) was studied as a function of atomic number of the backing material using thin sources of S^{35} and P^{32}, by comparing the activities with these sources evaporated on to 20 μg/cm² collodion films with those obtained with the sources evaporated on to metals (Be, Al, steel, Cd, Pb) or by placing the metals behind the collodion mountings. It was found that the backscattering increased with Z and was greater when the source was evaporated directly on the metal than when the metal was placed behind the collodion film mounting. The backscattering was found to be the same for the soft S^{35} beta-rays as for the harder P^{32} radiations provided that a correction was made for the absorption of the degraded backscattered particles in the air-gap and window—which was considerable in the S^{35} case. Self-scattering of S^{35} beta-rays in thick sources of varying atomic number was studied by comparing equally thick sources of benzidene sulphate (mean $Z = 4{\cdot}5$), $BaSO_4$ (mean $Z = 17{\cdot}3$), $PbSO_4$ (mean $Z = 21{\cdot}7$) and Hg_2SO_4 (mean $Z = 29{\cdot}7$). L. R. SHEPHERD

539.165 : 539.166

2972. Internal conversion electrons and other radiations from Cl^{34}. L. RUBY AND J. R. RICHARDSON. Letter in *Phys. Rev.*, **80**, 760 (*Nov.* 15, 1950).

The positron spectrum was complex, Kurie analysis showing three partial spectra with end-points 4·55 ± 0·11, 2·58 ± 0·26 and 1·3 ± 0·2 MeV. The Compton spectrum indicated γ-rays of energy 3·30 ± 0·14 and 2·13 ± 0·12 MeV, in agreement with the above data. An internal conversion line corresponding to a γ-ray of energy 0·145 MeV is also found. B. ROSE

539.165 : 539.166

2973. Radiations from Mo^{99} and Tc^{99m}. M. E. BUNKER AND R. CANADA. *Phys. Rev.*, **80**, 961–5 (*Dec.* 15, 1950).

The radiations from Mo^{99} (67 hr) and its metastable daughter Tc^{99m} (6 hr) have been measured in a magnetic lens spectrograph. The beta-ray spectrum consists of a group with an end-point energy of 1·23 MeV, one of 0·445 MeV and possibly a 3rd lower-energy group. The relative intensities of the 1·23 MeV to 0·445 MeV groups are 4 : 1. Gamma-rays have been found at 0·040, 0·140, 0·181, 0·367, 0·741 and 0·780 MeV. The gamma-rays at 0·040, 0·140 and 0·181 MeV are internally converted. The spectrum of Tc^{99} consists of one internally converted gamma-ray at 0·140 MeV. A disintegration scheme is proposed. A.

539.165 : 539.166

2974. The disintegration of Rb^{88}. M. E. BUNKER, L. M. LANGER AND R. J. D. MOFFAT. *Phys. Rev.*, **81**, 30–2 (*Jan.* 1, 1951).

The radioactive disintegration of Rb^{88} (17·8 min) has been investigated in a magnetic-lens spectrometer. Three beta-ray groups are observed having maximum energies of 5·13 ± 0·03, 3·29 ± 0·10 and 2·04 ± 0·15 MeV, with intensities of 66, 19 and 15% respectively. The 5·13 MeV group has a forbidden shape indicating a spin change of 2 units and a parity change. Gamma-rays are found with energies of 0·90, 1·86 and 2·8 MeV. A unique decay scheme is presented giving levels in Sr^{88} at 1·86 and 2·8 MeV. These levels are substantiated by a previous investigation of the disintegration of Y^{88} to Sr^{88}. Spins and parities of Rb^{88}, Sr^{88} and Y^{88} are discussed in the light of the one particle shell model. A.

539.165.08 : 537.533.72

An electrostatic beta-spectrograph. *See Abstr.* 2737

539.165.2

2975. On the 0→0 transition in O^{16}. I. S. SHAPIRO. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 1) 45–7 (1951) *In Russian.*

I. S. Shapiro [Abstr. 8961 (1950)] regarded this process as the emission of a neutral meson, subsequently decaying into an electron-positron pair. It is pointed out that it can be considered as a non-electromagnetic interaction between the nucleus and the electron-positron field in analogy to the theory of β-decay. It is then deduced that the interaction term in the Hamiltonian should be a bilinear form built up from 4-vectors of the type $i\Psi^*\gamma_4\gamma_5\gamma_\mu\Psi'$. W. J. SWIATECKI

539.165.2

2976. Recent investigation of the shapes of β-ray spectra. C.-S. WU. *Rev. Mod. Phys.*, **22**, 386–98 (*Oct.*, 1950).

Particular attention is devoted to studies of the low-energy end of the spectrum, and to forbidden shapes. Only the spectrum of Cl^{36} requires the assumption of mixed interactions for its explanation. Otherwise the observed results are in satisfactory agreement with theory. B. ROSE

539.165.2

2977. The interpretation of comparative half-lives in the Fermi theory of beta-decay. E. FEENBERG AND G. TRIGG. *Rev. Mod. Phys.*, **22**, 399–406 (*Oct.*, 1950).

The discussion is based on earlier work [Abstr. 929 (1944)]. The procedures for the calculation of f are discussed, and 9 charts given of f as a function of Z and W_0. Experimental data up to Nov., 1949, are presented as 2 histograms of the distribution of $\log ft$ values, and their peculiarities discussed. B. ROSE

539.165.2

2978. The shape of the low energy beta-spectrum of Rb^{86}. H. R. MUETHER AND S. L. RIDGWAY. Letter in *Phys. Rev.*, **80**, 750–1 (*Nov.* 15, 1950).

539.166

2979. Angular correlation of the two photons emitted in cascade by the nuclide $^{24}_{12}Mg$. G. CHARPAK AND F. SUZOR. *J. Phys. Radium*, **11**, 633–8 (*Nov.*, 1950) *In French.*

The measurements were carried out with a battery of Geiger counters, yielding results in accord with previous work [Abstr. 4967 (1949)]. The method is discussed in detail. B. ROSE

539.166

2980. The gamma-rays from neutron-activated gold. R. W. PRINGLE AND S. STANDIL. Letter in *Phys. Rev.*, **80**, 762–3 (*Nov.* 15, 1950).

539.166

2981. Internal conversion in the L_1-shell. H. GELLMAN, B. A. GRIFFITH AND J. P. STANLEY. *Phys. Rev.*, **80**, 866–74 (*Dec.* 1, 1950).

Analytical expressions obtained by Goertzel and Rose for the internal conversion of γ-radiation have been simplified from a computational viewpoint for the L-shell. Complex expressions involving gamma-functions and hypergeometric functions are simplified and reduced, in several cases, to algebraic expressions. Numerical calculations have been carried out for the L_I-shell, for electric dipole, electric quadrupole and magnetic dipole radiation. A.

539.166

2982. The gamma-ray spectrum of Ba^{131}. E. L. ZIMMERMAN, E. B. DALE, D. G. THOMAS AND J. D. KURBATOV. Letter in *Phys. Rev.*, **80**, 908–9 (*Dec.* 1, 1950).

539.166

2983. Auger effect in astatine. L. S. GERMAIN. *Phys. Rev.*, **80**, 937–8 (*Dec.* 15, 1950).

The K-capture decay of At^{211} has been studied using photographic emulsions. The number of Auger electrons per K shell vacated, defined as the Auger coefficient, has been found to be 0·106. This value is somewhat higher than that calculated from theory. Bi^{207}, which arises from the alpha-decay of At^{211}, was observed to decay by K-capture. A.

539.166

2984. Conversion coefficient of the 35-keV gamma-ray of Te^{125}. G. FRIEDLANDER, M. L. PERLMAN AND G. SCHARFF-GOLDHABER. Letter in *Phys. Rev.*, **80**, 1103–4 (*Dec.* 15, 1950).

539.165

2985. An investigation of the secondary electron spectrum of ^{198}Au. P. E. CAVANAGH, J. F. TURNER, D. V. BOOKER AND H. J. DUNSTER. *Proc. Phys. Soc., Lond., A*, **64**, 13–24 (*Jan.*, 1951).

The spectrum was studied using very strong sources, up to 0·3 curie, in a magnetic lens spectrometer. In addition to the well-known γ-ray at 0·411 MeV, evidence of two much less intense higher energy γ-rays at 0·67 MeV and 1·09 MeV has been found, both from the Compton and photoelectric spectra. The intensities of these two γ-rays with respect to the one at 0·411 MeV have been measured. Two photoelectric peaks at low energy, in about the region expected for $K\alpha$ and $K\beta$ X-radiation from elements in the neighbourhood of Au, were examined with radiators of different atomic number. The radiation responsible for these peaks was subjected to critical absorption measurements in the spectrometer. Its behaviour is compatible with the $K\alpha$ and $K\beta$ X-radiation of Au, and no evidence of Pt X-radiation, such as would suggest K-capture, has been found. A.

539.166 : 537.132

2986. The annihilation of positrons. One-quantum and two-quanta annihilation in motion. S. MERIÇ. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **15**, 179–204 (*July*, 1950).

See Abstr. 8971 (1950). Hard radiation from the 1-quantum annihilation of positrons at a nucleus is observed only when a heavy substance, Pb or Al, is used as annihilator. Radiation produced through 2-quanta annihilation in motion is also demonstrated. The intensity ratio of 1- to 2-quanta radiation agrees reasonably with theoretical predictions. The positrons were separated by the trochoidal method from the nuclear γ-rays of the Cu^{64} source, whose radiation is negligible. J. JACOBS

539.166.2

2987. The gamma-radiation of Ba^{131}. E. B. DALE, E. D. RICHERT, T. A. REDFIELD AND J. D. KURBATOV. Letter in *Phys. Rev.*, **80**, 763 (*Nov.* 15, 1950).

539.166.74

2988. The scattering of gamma-rays by nucleons. R. G. SACHS AND L. L. FOLDY. *Phys. Rev.*, **80**, 824–31 (*Dec.* 1, 1950).

In order to explore the possibility that information concerning nucleon structure could be obtained from the scattering of photons of energy near meson production threshold, the cross-section for the process has been calculated on the basis of the symmetrical scalar and pseudoscalar meson theories. The calculation was carried out in the non-relativistic, weak-coupling approximation, neglecting nucleon recoil effects. No divergence difficulties were encountered. In the scalar theory, the proton total cross-section is somewhat less than the Thompson cross-section (σ_0) as a consequence of interference between the scattering by the nucleon and that by the meson cloud. In pseudoscalar theory the total cross-section varies strongly with energy showing a resonance scattering effect with a peak value as high as $15\,\sigma_0$. The angular distribution in the scalar theory is very similar to that given by the Klein–Nishina formula: $(\frac{1}{2})(1 + \cos^2\theta)$. The pseudoscalar theory gives a quite asymmetric distribution, the form of asymmetry depending strongly on energy. The results may be taken as a strong indication that observation of the process could yield, in a sensitive way, information concerning the structure of the proton. A.

539.166.74

2989. The conservation of energy and momentum in Compton scattering. W. G. CROSS AND N. F. RAMSEY. *Phys. Rev.*, **80**, 929–36 (*Dec.* 15, 1950).

An experiment similar to that of Bothe and Maier–Leibnitz and others has been carried out to verify that in Compton scattering of 2·62 MeV quanta the scattered quantum and recoil electron are emitted without delay and in the relative directions demanded by the conservation laws. Better angular resolution and statistics and fewer experimental uncertainties than in the previous experiments were obtained. The results are in agreement with simultaneity and the conservation of energy and momentum. A.

539.166.74

2990. Resonant nuclear scattering of gamma-rays: theory and preliminary experiments. P. B. Moon. *Proc. Phys. Soc., Lond., A*, **64**, 76–82 (*Jan.*, 1951).

Since the lower excited states of nuclei have very small widths ($\ll$ 1eV), resonant scattering of gamma-rays requires precise matching of the energy available from the gamma-ray with the energy necessary to excite the scattering nucleus. Resonant scattering should be observable if (1) the emitting and scattering nuclei are of identical type, (2) the gamma-transition goes to the ground state, and (3) the source and scatterer are given such a relative velocity that Doppler effect restores the energy lost by the gamma-ray to nuclear recoils. Thermal velocities of the emitting and scattering nuclei broaden and correspondingly weaken the resonant scattering peak, and the cross-section at the optimum speed of $32E/A$ cm/sec is $3{\cdot}6\times10^{-3}(I\Gamma/E^3)(A/T)^{1/2}$ cm^2, where E and Γ are the energy and intrinsic width of the excited state in electron volts, I the isotopic abundance of the resonantly scattering isotope, A its atomic weight and T the absolute temperature. Preliminary experiments have been made with the 0·411 MeV radiation from the nucleus Hg^{198}, the source being carried by a high-speed rotor up to a speed of about 7×10^4 cm/sec and the scatterer being liquid mercury (10% Hg^{198}). A small but apparently significant increase of scattering was found, corresponding to a width Γ of the order of 10^{-5} eV. No such increase was observed with Ta^{181} gamma-rays scattered from Ta carbide. The negative result for Ta^{181} and the positive result for Hg^{198} are consistent with the latest information about the life-times of the excited states concerned, viz. $1{\cdot}1\times10^{-8}$ sec for Ta^{181} and $< 2\times10^{-10}$ sec for Hg^{181}. A.

NUCLEAR REACTIONS 539.17

539.17

2991. An experimental verification of the theory of compound nucleus. S. N. Ghoshal. *Phys. Rev.*, **80**, 939–42 (*Dec.* 15, 1950).

The compound nucleus Zn^{64} was formed by bombarding Ni^{60} with α-particles and Cu^{73} with protons. The ratios of the cross-sections $\sigma(\alpha,n)$: $\sigma(\alpha,2n)$: $\sigma(\alpha,pn)$ for Ni^{60} were found to agree with the ratios $\sigma(p,n)$: $\sigma(p,2n)$: $\sigma(p,pn)$ for Cu^{63}, giving a direct verification of the theory of compound nucleus. The observed cross-sections for the (p,n), $(p,2n)$ and (p,pn) reactions on Cu^{63} and (α,n), $(\alpha,2n)$ and (α,pn) reactions on Ni^{60} have been compared with the theoretical cross-sections calculated on the basis of the statistical model. The observed anomalous behaviour of the (p,pn) and (α,pn) cross-sections with respect to the $(p,2n)$ and $(\alpha,2n)$ cross-sections respectively are discussed. A.

539.17 : 521.042

The origin of the lighter elements. *See Abstr.* 2304

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 2796, 2800–16

539.172.11

2992. The angular distribution of protons emitted in some F(α, p) Ne resonance reactions. J. D. Jolly and F. C. Champion. Letter in *Proc. Phys. Soc., Lond., A*, **64**, 88–9 (*Jan.*, 1951).

539.172.11 : 539.166

2993. Gamma-rays from $Be^9(\alpha,n)$. J. Terrell. *Phys. Rev.*, **80**, 1076–80 (*Dec.* 15, 1950).

The gamma-ray spectrum produced by bombarding Be^9 with Po alpha-particles has been analysed by means of a 180° focusing pair spectrometer. The spectrum shows a single gamma-ray of energy $4{\cdot}45 \pm 0{\cdot}09$ MeV. The 6·7 MeV gamma-ray reported by earlier observers is not detected: no gamma-rays are present in the range 6 to 11 MeV to the extent of ½% of the 4·45 MeV intensity. Although no gamma-rays were detected below 4·45 MeV, the sensitivity of the spectrometer is much smaller in this low energy region, and the 2·7 MeV gamma-ray reported by Bothe and Dzhelepov would probably not be detected if present. The ThC″ gamma-radiation, investigated as a check on the operation of the spectrometer, is measured as $2{\cdot}62 \pm 0{\cdot}06$ MeV; no gamma-radiation is detectable in the vicinity of 3·2 MeV with intensity as great as ½% of that of the 2·62 MeV gamma-ray. A.

539.172.11 : 539.172.13

2994. On the bombardment of Li_2O and C by alpha-particles and deuterons. I. B. Berlman. *Phys. Rev.*, **80**, 775–81 (*Dec.* 1, 1950).

Photographic nuclear emulsions were used to record the scattered and recoiling particles when Li_2O and C targets were each independently bombarded by 10 MeV deuterons and 20 MeV alpha-particles. The 1·0 MeV level in C^{13} has been confirmed and a new level at 6·8 MeV in C^{13} has been determined. The relative scattering of deuterons and alpha-particles from nuclei in the ground state and in their various nuclear energy levels are illustrated. Finally the alpha-particle range-energy curve, as applied to Ilford E-1 nuclear emulsions, has been modified at higher energies. A.

539.172.13

2995. Search for Be^7 states using the Li^6 technique. G. R. Keepin, Jr Letter in *Phys. Rev.*, **80**, 768 (*Nov.* 15, 1950).

539.172.13

2996. Carrier-free radioisotopes from cyclotron targets. XII. Preparation and isolation of Be^7 from lithium. H. R. Haymond, W. M. Garrison and J. G. Hamilton. Letter in *J. Chem. Phys.*, **18**, 1685 (*Dec.*, 1950).

539.172.13

2997. Carrier-free radioisotopes from cyclotron targets. XIII. Preparation and isolation of Sc 44, 46, 47, 48 from titanium. J. D. Gile, W. M. Garrison and J. G. Hamilton. Letter in *J. Chem. Phys.*, **18**, 1685 (*Dec.*, 1950).

539.172.13

2998. Stars induced by 350- to 400-MeV protons. G. Bernardini, E. T. Booth and S. J. Lindenbaum. Letter in *Phys. Rev.*, **80**, 905 (*Dec.* 1, 1950).

539.172.13

2999. The neutron yield from the $C^{13}(p, n)N^{13}$ reaction. R. E. Adamson, Jr., W. W. Buechner, W. M. Preston, C. Goodman and D. M. Van Patter. *Phys. Rev.*, **80**, 985–7 (*Dec.* 15, 1950).

The neutron yield from $C^{13}(p, n)N^{13}$ has been studied up to a proton energy of $E_p = 3{\cdot}96$ MeV. A resonance is found at $E_p = 3{\cdot}76$ MeV which corresponds to an excited state in N^{14} at 11·07 MeV and coincides with a previously reported level deduced from the reactions of deuterons on C^{12}. This finding furnishes evidence that the same state of a compound nucleus can be excited by two entirely different processes. A.

539.172.13 : 539.164 : 539.166

3000. The angular distributions of the alpha-particles and of the gamma-rays from the disintegration of fluorine by protons. C. Y. Chao. *Phys. Rev.*, **80**, 1035–42 (*Dec.* 15, 1950).

The theoretical angular distributions of the alpha-particles and of the gamma-rays from the F + proton reactions are given. They are compared with the experimental data, and the following results are obtained: (1) Both angular distributions of the α_π-group and of the α_0-group favour the assumption of even parity of F^{19}. (2) If the parity of F^{19} is taken as even, then (*a*) the isotropic angular distribution of the gamma-rays at the resonances of 340 and 669 keV can be interpreted as due to the formation of Ne^{20} compound states of $J = 1^+$ by the capture of *s*-protons; (*b*) the slightly anisotropic angular distribution of the gamma-rays at the resonances of 598, 874 and 1 381 keV can be interpreted as due to the formation of Ne^{20} states of $J = 1^+$ by a mixture of *s*- and *d*-protons, or of $J = 2^-$ by *p*-protons; (*c*) the highly anisotropic distribution of the gamma-rays observed at 1 290 and 1 355 keV can be interpreted as due to the formation of Ne^{20} states of $J = 3^+$, and (*d*) the experimental data of the gamma-ray angular distribution and of the ratio $I(\alpha)_{140°}/I(\gamma)_{90°}$ are compatible with the assignment $j' = 3^-$ for the γ_1-level of O^{16}. In general it is possible to make spectroscopic assignments consistent with the experimental data but unique assignments will await further experimental results. A.

539.172.13

3001. The scattering lengths of the deuteron and *p-d* scattering. M. M. Gordon. Letter in *Phys. Rev.*, **80**, 1111–12 (*Dec.* 15, 1950).

539.172.13

3002. The (*p*, *n*) reaction on scandium and vanadium: energy levels of Ti^{46} and Cr^{52}. W. D. Baker, J. S. Howell, C. Goodman and W. M. Preston. *Phys. Rev.*, **81**, 48–50 (*Jan.* 1, 1951).

Thin targets of the monoisotopic elements V and Sc were bombarded with magnetically resolved protons at energies up to about 4 MeV. The neutron and gamma-ray yields were measured as functions of the proton energy. In each case a number of maxima are observed in the yield curves, presumably corresponding to excited states in the compound nucleus. A.

539.172.13

3003. Neutron spectra from nuclear reactions induced by 16-MeV protons. P. C. Gugelot. *Phys. Rev.*, **81**, 51–60 (*Jan.* 1, 1951).

The form of neutron spectra from (*p*, *n*) reactions has been studied by measuring proton recoil tracks in photographic emulsions which were exposed to neutrons produced by bombardment of 1 MeV thick targets of several elements with 16 MeV protons. The number of emitted neutrons with energy ε can be represented by $nd\varepsilon = \text{const}\,\varepsilon \cdot \exp(-\varepsilon/T)d\varepsilon$ for $\varepsilon > 2$ MeV. The values of T in MeV for different elements is found to be as follows: Be, $2{\cdot}3 \pm 0{\cdot}3$ (for $\varepsilon > 4$ MeV), $0{\cdot}9 \pm 0{\cdot}1$ (for $1 < \varepsilon < 4$ MeV); Al, $1{\cdot}3 \pm 0{\cdot}1$; Fe, $0{\cdot}95 \pm 0{\cdot}1$; Rh, $0{\cdot}85 \pm 0{\cdot}1$; Au, $0{\cdot}8 \pm 0{\cdot}1$; Tl, $0{\cdot}78 \pm 0{\cdot}1$. From these results the relative level density for the residual nucleus is calculated and compared with other experimental data and with theoretical predictions. The values for T_{exp} are lower than those predicted by Weisskopf's statistical model. A.

539.172.13

3004. Thin-target yield of $^{15}N(p, \alpha)^{12}C$. R. T. Pauli and C. Mileikowsky. Letter in *Nature, Lond.*, **167**, 155–6 (*Jan.* 27, 1951).

539.172.13 : 539.166

3005. Some gamma-rays from light elements under proton bombardment. J. H. Carver and D. H. Wilkinson. *Proc. Phys. Soc., Lond., A*, **64**, 199–201 (*Feb.*, 1951).

The energy of the photo-protons from deuterium, measured in an ionization chamber, has been used to determine the energy of gamma-rays produced by the proton bombardment of Be^9, B^{11}, C^{13}, F^{19}, Li^7, N^{15}. A.

539.172.13 : 539.172.4

3006. Hammer tracks in neutron and proton induced stars. E. W. Titterton. Letter in *Phil. Mag.*, **42**, 113–17 (*Jan.*, 1951).

The characteristics of 21 stars emitting "hammer" tracks observed in 5 000 stars produced by 150 MeV neutrons are given. These 21 events are attributed to the disintegration of light elements in the photographic emulsion, and possible reactions are discussed. E. P. George

539.172.13

3007. Energy levels of Mn^{56} and V^{52}. A. Ya. Abramov. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 5) 921–4 (1950) *In Russian.*

A 0·5 μ-thick target of Mn or oxide of V was bombarded with 3·8 MeV deuterons, the energy spectrum of protons from $Mn^{55}(d, p)Mn^{56}$ or $V^{51}(d, p)V^{52}$ being measured from the distribution of density of proton tracks in a photographic plate, reached by protons after traversing a wedge-shaped filter. Proton energies were calculated from cm air equivalent range, using curves of Livingston and Bethe [*Rev. Mod. Phys.*, **9**, 245 (1937)]. For each element, 7 certain and 2 probable energy groups were found; but 3 in the case of Mn, 2 in that of V are attributed to one or other of the reactions: $C^{12}(d, p)C^{13}$ and $O^{16}(d, p)O^{17}$. It is concluded that energy levels of Mn^{56} are (1·22), 1·77, 2·07, (2·45), 2·82 MeV and of V^{52}: 0·72, 1·31, (1·65), 2·04, (2·37), 2·75 MeV.

J. C. E. Jennings

539.172.13

3008. On the forward scattering of 3·1-MeV neutrons by the deuteron. J. SANADA AND S. YAMABE. Letter in *Phys. Rev.*, **80**, 750 (*Nov.* 15, 1950).

539.172.13

3009. Excited state of C^{14} from the $C^{13}(d,p)C^{14*}$ reaction. A. SPERDUTO, S. S. HOLLAND, JR., D. M. VAN PATTER AND W. W. BUECHNER. Letter in *Phys. Rev.*, **80**, 769–70 (*Nov.* 15, 1950).

By magnetic analysis of the disintegration products, using normal and enriched C targets, a level is reported at $6{\cdot}096 \pm 0{\cdot}015$ MeV. B. ROSE

539.172.13

3010. Proton groups from the $N^{14}(d,p)N^{15}$ and $N^{15}(d,p)N^{16}$ reactions. R. MALM AND W. W. BUECHNER. *Phys. Rev.*, **80**, 771–4 (*Dec.* 1, 1950).

The proton groups from N targets bombarded with deuterons have been investigated with a magnetic spectrometer. Seven groups have been identified as arising from the $N^{14}(d,p)N^{15}$ reaction with Q-values of $8{\cdot}615 \pm 0{\cdot}010$; $3{\cdot}339 \pm 0{\cdot}005$; $3{\cdot}310 \pm 0{\cdot}005$; $2{\cdot}287 \pm 0{\cdot}005$; $1{\cdot}451 \pm 0{\cdot}005$; $1{\cdot}306 \pm 0{\cdot}005$; and $0{\cdot}300 \pm 0{\cdot}005$. One group has been found which is assigned to $N^{15}(d,p)N^{16}$ with $Q = -0{\cdot}034 \pm 0{\cdot}005$ MeV. A.

539.172.13

3011. The high energy neutrons from the disintegration of C^{13} by deuterons. J. E. RICHARDSON. *Phys. Rev.*, **80**, 850–2 (*Dec.* 1, 1950).

An excitation curve for the 5 MeV neutrons resulting from C^{13} bombarded by deuterons has been obtained for neutrons emitted at $0° \pm 28°$ to the direction of the deuteron beam. The curve covers deuteron energies from 200 keV to 2·1 MeV. Resonances in the yield were observed at deuteron energies of 0·6, 0·9, 1·55 and 1·80 MeV with half-widths of 0·1, 0·4, 0·1 and 0·5 MeV respectively. These correspond to excited states in the intermediate N^{15} nucleus of 16·7, 16·9, 17·47 and 17·69 MeV. A.

539.172.13 : 539.163.2 : 539.155.2

3012. Concentration of A^{36} and A^{38} and study of the $A^{36}(d,p)A^{37}$ reactions and the beta-activity of A^{39}. A. ZUCKER AND W. W. WATSON. *Phys. Rev.*, **80**, 966–9 (*Dec.* 15, 1950).

The concentration of A^{36} up to 95·9% by the thermal diffusion method is described. Observation of the proton groups resulting from the deuteron bombardment of this gas gives the following Q-values for the $A^{36}(d,p)A^{37}$ reaction: 6·49, 5·05, 3·93, 2·95, 2·09, 1·86, 1·42 and 0·64 MeV. Comparison with the proton distribution from $A^{40}(d,p)A^{41}$ shows the importance of having well-separated isotopes for the resolution of proton groups of nearly the same energy from each isotope. The enrichment of A^{38} to 0·75% in this same gas makes measurement possible on the betas from the $A^{38}(d,p)A^{39}$ reaction. These A^{39} beta-particles have a half-life of 160 ± 5 sec and a maximum energy of about 2·1 MeV. A.

539.172.13

3013. Proton groups from the deuteron bombardment of boron. W. O. BATESON. *Phys. Rev.*, **80**, 982–4 (*Dec.* 15, 1950).

Protons emitted when boron enriched to 96% B^{10} was bombarded by 3·76 MeV deuterons have been observed at 90° and 0°. Groups corresponding to Q-values of $9{\cdot}18 \pm 0{\cdot}05$, $7{\cdot}03 \pm 0{\cdot}06$, $4{\cdot}70 \pm 0{\cdot}06$, $4{\cdot}15 \pm 0{\cdot}08$, $2{\cdot}26 \pm 0{\cdot}07$, $1{\cdot}36 \pm 0{\cdot}07$, $0{\cdot}70 \pm 0{\cdot}10$ and $0{\cdot}32 \pm 0{\cdot}10$ MeV were found. These have relative intensities at 90° of 1, 0·3, 0·8, 0·6, 16, 13 and 0·8. The intensity of the lowest energy group was not determined, since it was only just distinguishable from the scattered beam. The bombardment of unseparated B gave no significant results, because of the presence of large amounts of an impurity, probably Mg as the boride. A.

539.172.13

3014. Proton groups from the deuteron bombardment of F^{19} and P^{31}. R. C. ALLEN AND W. RALL. *Phys. Rev.*, **81**, 60–2 (*Jan.* 1, 1951).

The $F^{19}(d,p)F^{20}$ and $P^{31}(d,p)P^{32}$ reactions were studied with 3·76 MeV cyclotron deuterons. The $F^{19}(d,p)F^{20}$ ground-state Q-value was found to be $4{\cdot}16 \pm 0{\cdot}08$ MeV, giving $1{\cdot}00211 \pm 0{\cdot}00010$ MU for the F^{20}–F^{19} mass difference and $20{\cdot}00660 \pm 0{\cdot}00012$ MU for the mass of F^{20}. Excited states of F^{20} were found at 0·64, 0·97, 1·31, 1·91, 2·52, 2·83, 3·45 and 4·01 MeV. The $P^{31}(d,p)P^{32}$ ground-state Q-value was found to be $5{\cdot}52 \pm 0{\cdot}10$ MeV, giving $1{\cdot}00065 \pm 0{\cdot}00011$ MU for the P^{32}–P^{31} mass difference, and $30{\cdot}98286 \pm 0{\cdot}00021$ MU for the mass of P^{31}. Excited states of P^{32} were found at 0·50, 1·10, 1·36, 1·71, 2·22, 2·72 and 3·27 MeV. A.

539.172.13

3015. Excitation functions for spallation reactions on Cu. F. O. BARTELL, A. C. HELMHOLZ, S. D. SOFTKY AND D. B. STEWART. *Phys. Rev.*, **80**, 1006–10 (*Dec.* 15, 1950).

Excitation functions have been measured for 190 MeV deuterons from the 184 in Berkeley cyclotron on the natural isotopic mixture of Cu^{63} and Cu^{65}. Chemical separation of Zn, Cu, Ni, Co, Fe and Mn has been performed and the yields of several of the radioactive isotopes of these elements have been measured as a function of deuteron energy. The results seem to be in agreement with Serber's theory of high-energy processes and with other information on the yields of nuclear reactions at these energies. A.

539.172.13

3016. On angular distributions from (d,p) and (d,n) nuclear reactions. S. T. BUTLER. Letter in *Phys. Rev.*, **80**, 1095–6 (*Dec.* 15, 1950).

539.172.13

3017. Angular distributions of protons from the reaction $O^{16}(d,p)O^{17}$. H. B. BURROWS, W. M. GIBSON AND J. ROTBLAT. Letter in *Phys. Rev.*, **80**, 1095 (*Dec.* 15, 1950).

539.172.3

3018. Excitation function of the reaction $C^{12}(\gamma,p)B^{11}$. A. K. MANN AND J. HALPERN. Letter in *Phys. Rev.*, **80**, 470–1 (*Nov.* 1, 1950).

A thick (38 mg/cm²) graphite target was irradiated at an angle of 30° to the X-ray beam from a betatron (max. X-ray energy 18–25 MeV) and the photo-protons ejected at 90° to the beam were detected by scintillation counters. Knowing the energy spectrum of the X-ray beam at any max. energy, an uncorrected excitation function was obtained with threshold at 18·5 MeV and maximum at 22·2 MeV. The cross-section at max. is $1\text{–}5 \times 10^{-26}$ cm². A. O. STANESBY

539.172.3

3019. Neutron yield from $Be^9(\gamma, n)Be^8$ reaction. G. J. HINE AND F. E. SENFTLE. Letter in *Phys. Rev.*, **80**, 904 (*Dec.* 1, 1950).

539.172.3

3020. Neutron yields from photo-disintegration by gamma-rays from lithium. B. D. MCDANIEL, R. L. WALKER AND M. B. STEARNS. *Phys. Rev.*, **80**, 807–12 (*Dec.* 1, 1950).

The relative neutron yield of 33 elements has been studied using the gamma-ray spectrum which arises from proton bombardment of Li. The samples which were to be irradiated were placed in a block of paraffin. The neutrons were detected using 4 BF_3 proportional counters. Absolute gamma-ray and neutron intensity measurements yielded the value $(0{\cdot}055 \pm 0{\cdot}012)$ barn for the (γ, n) cross-section of Cu. Rough indications were also obtained concerning the relative neutron energy distribution from the samples. A.

539.172.3

3021. Gamma-neutron cross sections. H. E. JOHNS, L. KATZ, R. A. DOUGLAS AND R. N. H. HASLAM. *Phys. Rev.*, **80**, 1062–8 (*Dec.* 15, 1950).

A method is outlined for determining the total number of photons at each energy for a given irradiation from a betatron, assuming the bremsstrahlung photon distribution to be represented by an equation of Schiff and the response of an r-meter to be proportional to the absorption cross-section for photons in the wall material. The resulting activities produced by gamma-neutron reactions in Cu^{63}, Cu^{65}, Sb^{121}, Sb^{123} and Ta^{181} have been measured as functions of the maximum photon energy of the betatron. In each case the activity was normalized to saturation per gramme for 100 roentgens of radiation. A method is also outlined whereby these activation curves may be analysed to give the photo-neutron cross-section as a function of energy. The cross-section for Cu^{63} obtained by this method has its maximum at 17·5 MeV with a resonance half-width of 6 MeV and an integrated area of 0·7 MeV—barn. Maxima for the other nuclides are at somewhat lower energies and have essentially the same half-width. A.

539.172.3

3022. On the photo-disintegration of the deuteron by lithium and fluorine γ-rays. P. V. C. HOUGH. *Phys. Rev.*, **80**, 1069–75 (*Dec.* 15, 1950).

The photographic emulsion has been used to measure the differential cross-section for the photo-disintegration of the deuteron by 6·1 and 7·0 MeV γ-rays, and by 14·8 and 17·6 MeV γ-rays. A new method for the absolute measurement of γ-ray intensities leads to an absolute value for the total cross-section at 17·6 MeV of $(7{\cdot}2 \pm 1{\cdot}5) \times 10^{-28}$ cm². The results are in agreement with the theory for a "free" deuteron *P*-wave, but are not sufficiently accurate to fix with greater precision any of the parameters in the neutron-proton potential. A.

539.172.3

3023. Preparation of Co^{58m} by a (γ, n) reaction. D. CHRISTIAN AND D. S. MARTIN, JR. Letter in *Phys. Rev.*, **80**, 1110 (*Dec.* 15, 1950).

539.172.3

3024. Measurement of gamma-ray momenta and the thresholds of the photodisintegrations $^{12}C \rightarrow 3^4He$ and $^{16}O \rightarrow 4^4He$. F. K. GOWARD AND J. J. WILKINS. Letter in *Proc. Phys. Soc., Lond., A*, **64**, 93–4 (*Jan.*, 1951).

The method of momentum unbalance for the study of photodisintegration stars [Abstr. 6067 (1950)] is extended to the measurement of the above reaction thresholds, giving $7{\cdot}3 \pm 0{\cdot}5$ and $14{\cdot}8 \pm 1{\cdot}0$ MeV respectively. B. ROSE

539.172.3

3025. The photodisintegration of oxygen into two ^8Be nuclei. F. K. GOWARD AND J. J. WILKINS. Letter in *Phys. Soc., Lond., A*, **64**, 94 (*Jan.*, 1951).

Although O^{16} disintegrates into 4 He^4 predominantly via intermediate C^{12} nuclei [see Abstr. 1305 (1951)], 6 stars out of 200 show double "V" tracks characteristic of 2 ground-state Be^8 nuclei. T. G. PICKAVANCE

539.172.3

3026. Determination of fission and neutron yields, and the average neutron energy in the photo-disintegration of uranium. F. K. GOWARD, E. J. JONES, H. H. H. WATSON AND D. J. LEES. Letter in *Proc. Phys. Soc., Lond., A*, **64**, 95–6 (*Jan.*, 1951).

539.172.4

3027. The isotopes of xenon and krypton in pitchblende and the spontaneous fission of U^{238}. J. MACNAMARA AND H. G. THODE. Letter in *Phys. Rev.*, **80**, 471–2 (*Nov.* 1, 1950).

Fission product isotopes Xe^{129}, Xe^{131}, Xe^{132}, Xe^{134}, Xe^{136} and Kr^{83}, Kr^{84}, Kr^{86} arising from the spontaneous fission of U^{238} have been identified by mass-spectrometer studies of rare gases from Great Bear Lake pitchblende. A preliminary value of 7·0 is found for the yield ratio of Xe to Kr. The results indicate asymmetric fission with a displacement of the yield curve towards heavier masses in comparison with U^{234} and U^{236}. The yield of Xe^{132} appears to be abnormally high with respect to a smooth mass/yield curve drawn through the points provided by the other isotopes. L. R. SHEPHERD

539.172.4

3028. Interaction of fast neutrons with nitrogen. C. H. JOHNSON AND H. H. BARSCHALL. *Phys. Rev.*, **80**, 818–23 (*Dec.* 1, 1950).

Using neutrons from the $Li^7(p, n)Be^7$ reaction, the cross-sections for the reactions $N^{14}(n, p)C^{14}$ and $N^{14}(n, \alpha)B^{11}$ were measured for neutron energies from 150 to 2 100 keV. Resonances for the (n, p) reaction were found at 499, 640, 993 and 1 415 keV; for the (n, α) reaction at 1 415 and 1 800 keV. Information was obtained about the excited state of Be^7. It was found to lie 431 ± 5 keV above the ground state, and probabilities for its formation in the $Li(p, n)$ reaction were determined. A.

539.172.4

3029. Total cross sections of nuclei for 42-Mev neutrons. R. H. HILDEBRAND AND C. E. LEITH. *Phys. Rev.*, **80**, 842–5 (*Dec.* 1, 1950).

Total cross-sections of 33 elements for 42 MeV neutrons have been measured using the 184 in cyclotron as a source of neutrons and the $C^{12}(n, 2n)C^{11}$

reaction as a detector. Experimental details are described and the results are compared with those measured at other energies. A.

539.172.4

3030. The total scattering cross section of neutrons by hydrogen and carbon. E. E. Lampi, G. D. Freier and J. H. Williams. *Phys. Rev.*, **80**, 853–6 (*Dec.* 1, 1950).

The total cross-sections of H and C for neutrons has been determined by measuring the transmission of polythene and graphite scatterers for neutrons with energies 0·798, 1·078, 1·340, 1·578, 4·92 and 4·97 MeV. The correction for the finite geometry of the experiment was made by measuring the cross-section as a function of the scatterer area and extrapolating to zero area. The cross-sections are considered to be reliable to approximately ± 2%. A.

539.172.4

3031. The thermal neutron absorption cross section of silicon. C. W. Tittle and H. Faul. Letter in *Phys. Rev.*, **80**, 908 (*Dec.* 1, 1950).

539.172.4

3032. Radiative capture of neutrons in deuterium. B. B. Kinsey and G. A. Bartholomew. Letter in *Phys. Rev.*, **80**, 918–19 (*Dec.* 1, 1950).

539.172.4

3033. High energy neutron scattering by nuclei. S. Pasternack and H. S. Snyder. Letter in *Phys. Rev.*, **80**, 921 (*Dec.* 1, 1950).

539.172.4

3034. Total cross sections of Be, B, O and F for fast neutrons. C. K. Bockelman. *Phys. Rev.*, **80**, 1011–13 (*Dec.* 15, 1950).

Previous studies [Abstr. 3446 (1949)] of the cross-sections of Be and O as functions of neutron energy have been extended to higher energies. Three resonances in O were observed below 1·4 MeV, in agreement with those reported by the Minnesota group. In the range from 0·2 to 1·4 MeV, two resonances were found for Be. For energies below 1 MeV, one level was observed in B, while evidence for at least seven resonances was found for F in the energy interval from 0·01 to 0·7 MeV. The assignment of reduced widths and spin values to the compound states is possible in certain cases. A.

539.172.4

3035. The neutron cross section of Mn below 5 000 eV. S. P. Harris, C. T. Hibdon and C. O. Muehlhause. *Phys. Rev.*, **80**, 1014–17 (*Dec.* 15, 1950).

Experimental measurements of the neutron-scattering and absorption cross-sections of Mn at energies less than 5 000 eV are shown to fit a two-level Breit–Wigner formula. Only one parameter, the nuclear radius, need be adjusted to do this. This adjustment having been made, it is possible to obtain (*a*) the total scattering, the coherent scattering, and the absorption cross-section for thermal neutrons, (*b*) the angular momenta of the 2 low-energy resonances, and (*c*) the proper cross-section behaviour in the wing of the lowest-energy resonance. The evidence presented demonstates in detail that the Breit–Wigner formulation yields the proper neutron-scattering cross-section as a function of energy. A.

539.172.4

3036. Stars produced in nuclear emulsions by 150 MeV neutrons. E. W. Titterton. Letter in *Phil. Mag.*, **42**, 109–12 (*Jan.*, 1951).

Gives prong-distribution and angular distribution of star prongs. The cross-section for star production is stated to be 0·06× geometric. E. P. GEORGE

539.172.4

3037. Angular distribution of 14-Mev neutrons scattered by tritons. J. H. Coon, C. K. Bockelman and H. H. Barschall. *Phys. Rev.*, **81**, 33–5 (*Jan.* 1, 1951).

Tritons recoiling from 14 MeV neutrons were observed in a coincidence counter telescope. The angular distribution of neutrons scattered through angles between 180° and 90° in the centre-of-mass system was investigated. Absolute differential scattering cross-sections were obtained by comparison with H. No evidence for the presence of disintegration protons or deuterons was found. A.

539.172.4

3038. Total cross-sections of hydrogen and carbon for high energy neutrons. A. E. Taylor, T. G. Pickavance, J. M. Cassels and T. C. Randle. *Phil. Mag.*, **42**, 20–8 (*Jan.*, 1951).

Measurements of the attenuation of a beam of high-energy neutrons in C and polythene have been made in good geometry. The total cross-sections of H and C have been found to be $0{\cdot}0464 \pm 0{\cdot}0012 \times 10^{-24}$ cm^2 and $0{\cdot}330 \pm 0{\cdot}003 \times 10^{-24}$ cm^2 respectively, at an effective neutron energy of 156 ± 3 MeV. For previous brief report see Abstr. 8247 (1950). A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

3039. Absolute selection rules for meson decay. D. C. Peaslee. *Helv. Phys. Acta*, **23** *No.* 6–7) 845–54 (1950).

All selection rules implied by conservation of angular momentum and of parity, are obtained for decay of an isolated particle. Other selection rules are particular to the interactions existing in the theory considered or hold only to a certain approximation. These "absolute" selection rules forbid a limited number of two-particle decay processes only.

R. H. DALITZ

539.18

3040. Are mesons complex particles? M. el Nadi. Letter in *Phys. Rev.*, **80**, 754 (*Nov.* 15, 1950).

Discusses consequences of the assumption that a π-meson is composed of a charged μ-meson and a neutral anti-μ-meson. E. P. GEORGE

539.18

3041. Further remarks on the absorption of π^--mesons in hydrogen. R. E. Marshak, S. Tamor and A. S. Wightman. Letter in *Phys. Rev.*, **80**, 765–6 (*Nov.* 15, 1950).

Theoretical discussion of the experimental results of Panofsky *et al.* [Abstr. 8235 (1950)] which showed two modes resulting in γ-ray emission or neutral

meson emission. The only consistent weak coupling theory which is possible is a PS field for π^0 and a PS or PV field for $\pi^\pm$. E. P. GEORGE

539.18

3042. On the absorption of π^--mesons in deuterium. S. TAMOR AND R. E. MARSHAK. Letter in *Phys. Rev.*, **80**, 766 (*Nov.* 15, 1950).

Theoretical calculations of the relative probabilities of different modes of absorption: neutron emission, γ-ray emission or neutral meson emission, for various types of meson field. Comparison with observation seems to rule out the possibility that charged π-mesons could be scalar or vector mesons. E. P. GEORGE

539.18

3043. Production of a π^+ meson beam using the deflected proton beam of the 184-inch synchrocyclotron. C. RICHMAN, M. SKINNER, J. MERRITT AND B. YOUTZ. Letter in *Phys. Rev.*, **80**, 900 (*Dec.* 1, 1950).

539.18

3044. Large angle scattering of π^--mesons. H. BRADNER AND B. RANKIN. Letter in *Phys. Rev.*, **80**, 916 (*Dec.* 1, 1950).

Scattering at $\sim$ 38 MeV was studied by the photographic-plate technique. The frequency plot of scatters between 5° and 30° (128 events) is in agreement with single Coulomb scattering. The total cross-section for large-angle scattering (9 events) and star production (5 events) were roughly equal to $\frac{1}{2}$ the nuclear area. Two cases were observed in which a meson ended abruptly with no visible star or scatter. W. J. SWIATECKI

539.18 : 530.145

3045. On the nature of the τ-meson. II. H. FUKUDA, S. HAYAKAWA AND Y. MIYAMOTO. *Progr. Theor. Phys.*, **5**, 352–72 (*May–June*, 1950).

Calculations in Part I [Abstr. 8232 (1950)] on the decay of τ-mesons by the process $\tau \rightarrow \pi + \pi_0$ are supplemented by more on the processes $\tau \rightarrow \pi + \gamma$ and $\tau \rightarrow 3\pi$. Most of the possible types of meson and coupling are used, but no higher calculations are made where the lowest-order process is forbidden. A discussion of the results in the light of the experimental evidence still leaves many possible combinations. G. J. KYNCH

539.18 : 537.533.79

3046. On the nature of the secondary radiation of ordinary mesons. R. MAZE AND J. THOUVENIN. *C.R. Acad. Sci., Paris*, **231**, 1477–9 (*Dec.* 18, 1950) *In French.*

From counter measurements at depths underground of 20 and 75 m H_2O it is concluded that the radiation investigated consisted of low-energy photons (2 to 10 MeV) resulting from knock-on electrons.

E. P. GEORGE

539.18 : 537.591

3047. Detection of μ-mesons and other fast charged particles in cosmic radiation by the Cerenkov effect in distilled water. J. V. JELLEY. *Proc. Phys. Soc., Lond., A*, **64**, 82–7 (*Jan.*, 1951).

The Čerenkov effect has been established for the passage of cosmic-ray μ-mesons through distilled water. The light pulses were observed using a photomultiplier and fast amplifier; the experiments were carried out using the detector alone, and in a coincidence-telescope arrangement. The ratio of the light emitted in the downward and upward directions was measured as a function of discriminator bias. In addition measurements were carried out at various depths of water and with various orientations of the detector with respect to the vertical. Estimates of the absolute efficiency were made and other characteristics of the detector are discussed. A.

539.18 : 539.17

3048. Nuclear interaction of π^--mesons. G. BERNARDINI, E. T. BOOTH, L. LEDERMAN AND J. TINLOT. Letter in *Phys. Rev.*, **80**, 924–5 (*Dec.* 1, 1950).

Three kinds of 30–50 MeV interaction were observed in photographic emulsions: (1) star production (22 events), (2) large-angle scattering (3 events), (3) disappearance in flight (2 events). A mean free path of 29 cm for all 3 kinds of events was obtained (cf. geometric mean free path of 25 cm for the emulsion used). W. J. SWIATECKI

539.18 : 539.172

3049. On the production of low energy π-mesons in nuclear collisions. N. DALLAPORTA AND M. MERLIN. *Nuovo Cim.*, **7**, 963–6 (*Nov.*, 1950) *In Italian.*

It is pointed out that some indication of the energy spectrum of π-mesons between 10 and 100 MeV may be deduced from Powell's early experiments at Jungfraujoch [see Abstr. 3298 (1949)], which give the number of mesons generated in a Pb screen placed laterally to a pile of nuclear plates. It is shown in fact that, under a number of simplifying assumptions, one may calculate with fair approximation the intensity of mesons in the plates at Jungfraujoch from the energy spectrum observed at Bristol [see Abstr. 6622 (1950)]. L. PINCHERLE

539.181 : 539.152.2

An atomic beam source. *See Abstr.* 2927

539.185

3050. On neutron distribution in a moderator. P. JANSSENS AND A. GRIBAUMONT. *Bull. Acad. Roy. Belge Cl. Sci.*, **36** (*No.* 8–9) 616–26 (1950) *In French.*

The spatial and energy distributions of neutrons from a monokinetic point source, slowing down in an infinite moderator, are studied. Expressions are derived for the energy and space density of neutrons at a given distance from a source, in the case of a non-capturing medium consisting of one or more nuclear species, using generalizations of methods due to Langevin and Flügge. The case of neutrons slowing down in a capturing moderator (H), both for constant and $1/v$ capture, is also studied. L. R. SHEPHERD

539.185

3051. Spatial and energy distribution of neutrons in a capturing moderator. M. DEMEUR. *Bull. Acad. Roy. Belge Cl. Sci.*, **36** (*No.* 8–9) 627–38 (1950) *In French.*

The space-energy distribution of neutrons in a capturing medium is studied by a method of approximation, which treats the ratio of total to transport cross-sections as constant over each of a series of equal logarithmic energy intervals. This method is most accurate when the atomic mass of the moderator is fairly high. L. R. SHEPHERD

539.185

3052. The thermal neutron diffusion length of paraffin. C. W. TITTLE. Letter in *Phys. Rev.*, **80**, 756 (*Nov.* 15, 1950).

539.185

3053. Depression of the thermal neutron density by a detecting foil. C. W. TITTLE. Letter in *Phys. Rev.*, **80**, 756–7 (*Nov.* 15, 1950).

539.185

3054. Double transmission and depolarization of neutrons. M. BURGY, D. J. HUGHES, J. R. WALLACE, R. B. HELLER AND W. E. WOOLF. *Phys. Rev.*, **80**, 953–60 (*Dec.* 15, 1950).

Slow neutrons from the chain reacting pile, polarized by passage through highly magnetized Fe, have been analysed by transmission through additional Fe (the "double transmission" effect). The large double transmission effects expected from the polarization cross-section of Fe were obtained only when the magnetic field between polarizer and analyser was adjusted carefully to obtain non-adiabatic transitions of the neutrons relative to the field. The general methods developed have been used to measure the change in polarization of a neutron beam with passage through unmagnetized Fe. The rate of depolarization is a measure of the domain size in the Fe and domain sizes have been measured in this way for a number of Armco Fe samples of different metallurgical treatment. A.

539.185 : 778.3

3055. Improvements in the Li^6 technique. G. R. KEEPIN, JR. Note in *Rev. Sci. Instrum.*, **21**, 933 (*Nov.*, 1950). See Abstr. 5312 (1950).

STRUCTURE OF SOLIDS 539.2

539.21

3056. The configurational partition functions for binary solid solutions and the equilibrium degrees of local and long range order. J. A. WASASTJERNA. *Comment. Phys. Math., Helsingf.*, **14** (*No.* 7) 8 *pp.* (1950).

A theory is developed giving the formula

$$\theta_{\alpha\beta}^2/\theta_{\alpha\alpha}\theta_{\beta\beta} = 4e^{-\frac{z}{2}(2w_{\alpha\beta}-w_{\alpha\alpha}-w_{\beta\beta})/kT}$$

where $\theta_{\alpha\beta}$ denotes the fraction of pairs of neighbouring sites, occupied by two different particles A and B; $w_{\alpha\alpha}$, $w_{\alpha\beta}$ and $w_{\beta\beta}$ denote the mutual potential energies of the AA, AB and BB pairs, respectively, and z denotes the number of geometrically equivalent sites or neighbours. This formula is identical with that of Bethe when $z = 2$. It follows that an increasing number of neighbours should bring about an increase of the degree of local order. It seems that the configurational energy of the superstructure depends not only on the nearest neighbours but also on the degree of long-range order. F. LACHMAN

539.21

3057. Surface tension of a crystalline surface. R. DEFAY. *J. Phys. Radium*, **11**, 615–18 (*Nov.*, 1950) *In French.*

The surface tension of a solid surface is defined in purely mechanical terms which avoids confusion with the surface free energy. Wulff's relations which connect the positions of the faces of a crystal with their surface tensions are shown to be conditions of applicability of the notion of surface tension to solid faces and not, as generally supposed, laws of physico-chemical equilibrium. H. P. MYERS

539.215

3058. On the "spheroidization" of metallic particles. V. I. DANILOV AND D. S. KAMENETSKAYA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 237–40 (1950) *In Russian.*

Small particles 0·5–5 mm in dia. of pure Na, m.p. 97·6°, and of Na containing small amounts of Hg were found to assûme a spherical form on keeping them at temps. near the m.p. The velocity with which the different surfaces of the particles merge into a spherical surface increases with increase (*a*) in temp. and (*b*) Hg content. It is postulated that spheroidization in the case of pure Na is a process whereby the particles approach their equilibrium form, while for particles containing Hg it is postulated that spheroidization is related to the presence of a solute in the Na and the development of a liquid film on the surface near the points of crystallization.

W. HUGHES

539.215.4

3059. Methods of sieve analysis with particular reference to bone char. F. G. CARPENTER AND V. R. DEITZ. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 328–45 (*Oct.*, 1950).

The procedure for separating particle sizes of solid adsorbent by sieving has been studied in detail because of the influence of the particle size on adsorbent properties. The investigation was conducted chiefly with sieve openings in the range between U.S. Standard Sieves No. 8 and No. 80. The largest source of error is in the testing sieves themselves. This is due to the tolerances permitted by the present specifications. It is feasible to calibrate testing sieves by the use of a calibrated sample of spherical glass beads and thus obtain the opening that is effective in sieving. The calibration of testing sieves in this manner can lead to reproducible sieve analyses by different laboratories. A simple procedure is proposed to determine the uniformity of sieve openings and, thereby, to furnish a criterion for the discard of distorted sieves. A.

539.215.4

3060. The distribution of particle sizes. F. KOTTLER. *J. Franklin Inst.*, **250**, 419–42 (*Nov.*, 1950).

See Abstr. 1338 (1951). In fitting the best straight line through a number of points plotted on a logarithmic scale, the deviations from the line in the region of high numbers correspond to higher absolute deviations than in the low-number region, so it is unsound to estimate by eye. The correct method is to calculate a straight line such that the sum of weighted square deviations is a minimum (Mueller weights).

N. CORCORAN

539.215.4

3061. The natural width of a grain boundary in a metal. J. L. SNOEK. Letter in *J. Appl. Phys.*, **22**, 109 (*Jan.*, 1951).

539.217

3062. Experimental determination of the diffusion coefficient of sodium ions in sodium chloride. A. MURIN AND B. LURE. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 5) 933–5 (1950) *In Russian.*

An attempt at developing an experimental method for the determination of the diffusion coefficient of Na^+ in solid NaCl. Radioactive Na^{24} ($T = 14{\cdot}8$ hr) was used for the determination of the auto-diffusion coefficient of Na^+. The values obtained (7 to 14 $cm^2/sec \times 10^{10}$ for the interval 650°–680°c) are in good agreement with those calculated on theoretical basis. F. LACHMAN

539.217

3063. Calculation of diffusion penetration curves for surface and grain boundary diffusion. J. C. FISHER. *J. Appl. Phys.*, **22**, 74–7 (*Jan.*, 1951).

Diffusion in solids is known to occur along grain boundaries and over free surfaces more rapidly than through the interiors of crystals. In order to facilitate quantitative investigation of grain boundary and surface diffusion, a mathematical analysis of the problem has been completed, assuming that grain boundary diffusion is analogous to the diffusion of heat along a thin Cu foil imbedded in cork. The calculated diffusion-penetration relationship for grain boundary diffusion is shown to agree with the experimentally determined grain boundary self-diffusion of Ag. A.

539.217 : 669

3064. Spectrographic analysis of metallic layers obtained by thermal diffusion of Cr in iron and steel. F. MALAMAND. *C.R. Acad. Sci., Paris*, **232**, 236–8 (*Jan.* 15, 1951) *In French.*

Using a 10 000 V spark, and a spectrograph operating between 2 500 A and 3 200 A, it was found possible to estimate Cr contents between 10% and 50% with a r.m.s. error of 2·3% on 45 analyses using Fe and Cr lines. By using this apparatus to determine the Cr content of the surface layer, removing this layer by electrolysis, estimating the Cr in the newly exposed layer, etc., the distribution of Cr throughout the specimen was investigated. The results agree with the theory that diffusion of gaseous Cr into the Fe has taken place, including the discontinuity in the rate of diffusion at 13% Cr, where the crystal structure of the alloy changes. N. CORCORAN

539.217.5

3065. Permeability of glass wool and other highly porous media. A. S. IBERALL. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 398–406 (*Nov.*, 1950).

An elementary treatment is developed for the permeability of fibrous materials of high porosities, based on the drag of the individual filaments. It is believed that the same treatment is valid for other highly porous media. A brief historical review is given of theories relating the permeability to the structure of porous media. The applicability of the currently accepted permeability theory, based on the hydraulic radius, only to media of low porosities is discussed. Both approaches may be extended to permit approximate correlation for intermediate porosities. For fibrous materials of high porosity, it is shown that the effect of fluid inertia results in a permeability that varies with flow even at low Reynolds number. The permeability to gaseous flow is also shown to vary with the absolute gas pressure. This variation is appreciable when the molecular mean free path is of the same order of magnitude as the separation between filaments or particles in the medium. Data suitable for the design of linear flowmeters utilizing fibrous materials of high porosity are given, including data on the useful porosity range of fibrous media. A.

539.218

3066. The consolidation of soil. J. MANDEL. *C.R. Acad. Sci., Paris*, **232**, 209–11 (*Jan.*15, 1951) *In French.*

A brief outline is given of a theoretical study of the consolidation of soil with time, it being assumed that the soil is saturated with water and has an elastic structure. A horizontal bed of soil of given vertical thickness is loaded vertically and is assumed bounded by the walls of an impermeable vertical cylinder having its axis in line with the load. The radius of this cylinder is subsequently made infinite, and the axial vertical settlement is computed for a concentrated axial vertical load. The work is then extended to a soil layer of infinite thickness. A. C. WHIFFIN

539.219.1

3067. On some properties of the Cu–Mn alloy system. T. SATO. *J. Phys. Soc. Japan*, **5**, 287–92 (*Sept.–Oct.*, 1950).

No evidence has been found by the author for the existence of a superlattice of Cu_3Mn alloy. When the alloy is oxidized the negative resistance temp. coeff. disappears. When the specimen is subsequently quenched the negative temp. coeff. appears again. The temp. coeff. is explained by assuming that it is a function of the density of the Fermi surface of the *d*-band which, when decreasing with increasing temperature, may account for a negative temp. coeff. Alloys other than Cu–Mn also have a negative temp. coeff., for instance, Bi alloys. W. SUMMER

539.219.1

3068. Formation of order in the alloy $CdMg_3$. H. STEEPLE AND H. LIPSON. Letter in *Nature, Lond.*, **167**, 110–11 (*Jan.* 20, 1951).

The formation of order in the alloy $CdMg_3$ has been shown to be accompanied by similar X-ray diffraction effects to those that occur in the formation of order in the alloy $AuCu_3$. H. P. MYERS

539.219.2 : 536.2

3069. Temperature stresses in irregular solids. R. D. HOYLE. Letter in *Nature, Lond.*, **167**, 30–1 (*Jan.* 6, 1951).

539.23 : 535.39 : 537.312

3070. The properties of evaporated gold and tungsten oxides. P. G. WILKINSON. *J. Appl. Phys.*, **28**, 226–32 (*Feb.*, 1951).

Gold blacks, prepared by evaporating Au from a W filament in tank N_2 at several mm pressure, were found to contain W oxides which greatly affected the optical and electrical properties. Deposits containing more than 0·5 mole % of W oxides were black and showed resistivities 10^3 to 10^8 times that of bulk Au. The resistivities of Au blacks increased on exposure to O_2. On the other hand, oxide-free deposits were yellow and possessed a low stable resistivity, unaffected by exposure to O_2. Exposure to air or O_2 caused an increase in the electrical resistance, and

optical transmission of films of W dioxide and W trioxide evaporated in high vacuum. It was concluded that evaporated films of pure Au are unaffected by exposure to air and that the changes in optical and electrical characteristics, often observed in evaporated Au films exposed to air, may be attributed to contamination by oxides of W. It was also concluded that so-called Au blacks are black because of the presence of W oxides, since Au evaporated in pressures of several millimetres of O-free N_2 formed bright reflecting films rather than black absorbing deposits. A.

539.23 : 539.27

3071. Orientation of fatty acid and soap films on metal surfaces. J. W. MENTER AND D. TABOR. *Proc. Roy. Soc. A*, **204**, 514–24 (*Jan.* 9, 1951).

An electron-diffraction study has been made of the structure and orientation of fatty acid films and soap films adsorbed on metal surfaces. In particular, an examination has been made of the effect of temperature on the orientation, using the reflection method and an improved experimental technique. The results show, as previous workers have found, that at room temperature the first layer is generally oriented with the hydrocarbon chains normal to the surface, though other orientations may be obtained by "rubbing" the film. As the temperature is raised the "layer lines" become increasingly less distinct, and at a characteristic temperature only the pattern of the substrate is observed. This transition is a true disorientation effect, since on cooling orientation is again observed. At higher temperatures the film may evaporate completely from the surface. With fatty acids on non-reactive metals such as Pt the disorientation temperature is close to the bulk melting-point of the fatty acid. On reactive metals such as Zn and Cd the disorientation occurs at higher temperature which is close to the bulk melting-point of the appropriate metallic soap suggesting the formation of the soap by chemical reaction. This is supported by the similar behaviour of thin films of metallic soap deposited directly on the metal substrate. These observations are compared with the lubricating properties of fatty acids and soaps on metal surfaces. A.

539.23 : 539.27

3072. Structure of thin films of aliphatic esters and alcohols on metals. J. V. SANDERS AND D. TABOR. *Proc. Roy. Soc. A*, **204**, 525–33 (*Jan.* 9, 1951).

An electron-diffraction study. The effect of temperature has also been examined by transmission and reflection methods. Transmission experiments on small crystals of the alcohols show that the orthorhombic structure observed at room temperature gives place to a hexagonal structure at temperatures below the bulk melting-point. These results are analogous to those observed by Müller (1932) with hydrocarbons using X-ray diffraction. When melting occurs there is a marked increase in the lattice parameter, but the packing appears to remain essentially hexagonal. The esters behave similarly. Reflection experiments on thin films of alcohols and esters deposited on metal surfaces show that the first molecular layer is generally oriented with the hydrocarbon chains normal to the surface. With alcohols the monolayer loses its orientation at a temperature close to the bulk melting-point of the alcohol, and the disorientation temperature does not depend appreciably on the nature of the metallic substract. With esters it is difficult to obtain diffraction patterns owing to evaporation, but the evidence again points to a disorientation of the ester at its bulk melting-point. On zinc and cadmium surfaces, however, good orientation may be obtained up to elevated temperatures, and the behaviour is similar to that observed with metallic soaps. The bearing of these results on the nature of the disorientation process is discussed and a comparison made with the boundary lubricating properties of these substances. A.

539.23 : 541.124

3073. Low temperature oxidation of copper. I. Physical mechanism. T. N. RHODIN, JR. *J. Amer. Chem. Soc.*, **72**, 5102–6 (*Nov.*, 1950).

The validity of Mott's hypothesis was evaluated by a low temperature study of the oxidation of the cubic face of single crystals of copper in the temperature range 78 to 335°K. By use of a sensitive quartz vacuum microbalance, actual surface areas were determined from microadsorption isotherms and the growth of very thin oxide films were followed with an accuracy of 2%. The rate equation derived from Mott and Cabrera's hypothesis was found to be valid with some limitations for film thicknesses in the range of 5–50 Å and temperatures from 78 to 300°K. A.

539.24 : 539.53 : 621.785.5

3074. Controlling hardness and microstructure during induction hardening. G. A. WARWICK. *Gen. Elect. Rev.*, **53**, 21–6 (*Nov.* 1, 1950).

The work described aimed at establishing means of precise control of the high-speed case-hardening of production components by semi-automatic h.f. induction heating. Timers were replaced by a calibrated photoelectric pyrometer controlling the temperature via a relay. Quenching by submersion was eventually discarded and water sprays substituted. The properties of the case produced were determined by micro-hardness and micro-structure examination and data covering a wide range of operating conditions are given in form of a series of graphs. The temperature distribution as determined by skin effect and conduction are discussed with particular reference to the effect of the change, with rising temperatures, in the magnetic and thermal properties of the material. J. H. O. SMERD

539.24 : 541.138 : 669

3075. Electrolytic polishing and oxidation of titanium and examination of micrographic structure by these methods. P. A. JACQUET. *C.R. Acad. Sci., Paris*, **232**, 71–3 (*Jan.* 3, 1951) *In French.*

Polishing of pure Ti, commercial Ti, Ti–Cr–Fe alloys and Ti–C alloys is carried out in an electrolyte of acetic anhydride, perchloric acid and water; the resulting surface may be etched by the usual reagents. Anodic oxidation produces thin particles of oxide whose colours depend on the crystallographic characteristics of the supporting layer. N. CORCORAN

539.26

3076. Latex particle size from X-ray diffraction peaks. K. L. YUDOWITCH. *J. Appl. Phys.*, **22**, 214–16 (*Feb.*, 1951).

A high resolution camera was constructed for small angle X-ray scattering. Measurements with this camera on Dow latex 580G exhibit a number of concentric rings. Each ring is associated with a theoretical maximum of scattered intensity predicted by the spherical X-ray form factor corrected for packing. The particle diameter is then computed from the position of each ring. Twenty measurements yield a diameter of 2 780 Å with a probable error of $< \pm 1\%$. A.

539.26 : 537.591 : 535.42

3077. Periodic statistical distortion of unidirectionally ordered diffractors, with application to collagen. R. S. BEAR AND O. E. A. BOLDUAN. *J. Appl. Phys.*, **22**, 191–8 (*Feb.*, 1951).

The diffraction expected of distorted, one-dimensionally ordered cylinders (fibrils) is considered quantitatively. The distortion involved is statistically of cylindrical symmetry about any point in the fibril, and periodic along the fibril axis. An important case is that of the "mixed perfect and imperfect fibril," in which, at some axial levels, distortion is absent, and at others it is appreciable. For such systems it is shown that the reciprocal-space disk corresponding to a given diffraction layer line may be regarded as composed of three sub-disks: one of perfection, whose central intensity is maximal and whose diameter is small and independent of layer-line index; another of longitudinal or axial imperfection, whose central intensity is also maximal; and a third, related to radial imperfection, whose intensity is noncentrally maximal. Both types of imperfection sub-disk expand linearly in diameter with increase in index. It is demonstrated briefly that certain dry collagen specimens exhibit small-angle diffraction in which the characteristics of the three types of sub-disk are apparent. A.

539.26 : 541.13

3078. The structure of metal deposits obtained by electrochemical displacement upon zinc. M. E. STRAUMANIS AND C. C. FANG. *J. Electrochem. Soc.*, **98**, 9–13 (*Jan.*, 1951).

An attempt is made to identify the composition and the structure of nonadherent immersion deposits of noble metals on Zn. Cu, Au, Ni and Ag deposits were examined by X-rays. All of them contained redeposited Zn. Cu deposits contained approximately 9 to 13 atom % in solid solution, and Ni deposits contained 17 to 20% in solid solution; Au deposits large amounts and Ag deposits below 0·5 atom %. The grain size of the deposits was very small because their growth was hampered by co-deposited Zn. During the displacement of Ag, Zn deposited mostly as a very thin layer on the surface of the grains. The other three metals absorbed Zn readily, forming α-phases. The displacement of the noble metal occurs because of the activity of the local cells; Zn acts as anode and the noble metal forms very small cathodes. The redeposition of Zn on these cathodes is possible because it is deposited in form of a solid solution, the free energy of which is reduced. A.

539.264

3079. Low-angle X-ray scattering from ramie and jute. J. ADAMS. Letter in *Nature, Lond.*, **167**, 78 (*Jan.* 13, 1951).

539.27

3080. Apparatus for the study of insulating surfaces by electron diffraction. J. J. TRILLAT AND S. OKETANI. *Vide*, **5**, 827–30 (*July–Sept.*, 1950) *In French.*

For abstract see Abstr. 9030 (1950).

539.27

3081. Apparatus for the study by electron diffraction of the effect of temperature on surface films. J. W. MENTER AND J. V. SANDERS. *J. Sci. Instrum.*, **27**, 335–6 (*Dec.*, 1950).

This paper describes specimen holders for heating "reflection" and "transmission" specimens for examination by electron diffraction. The temperature of the specimens may be measured to within a few degrees in the range 15–200°c. A film holder is also described with which it is possible to make up to twenty exposures without breaking the vacuum of the diffraction camera. A.

539.27

3082. Replica techniques in electron microscopy. A. W. AGAR AND R. S. M. REVELL. *Brit. J. Appl. Phys.*, **2**, 8–11 (*Jan.*, 1951).

Precautions for obtaining clean and reliable replicas for the study of large areas of metal surfaces are outlined. Modifications to the backed replica technique, and the application of preshadowing in metallographic studies are described. A.

539.27

3083. A new method of preparing paste and powder specimens for the electron microscope. F. SCHOFIELD. *Brit. J. Appl. Phys.*, **2**, 18–20 (*Jan.*, 1951).

A new method of preparing specimens of pastes and powders for examination by the electron microscope which avoids aggregation of the solid particles is described. A sample of the paste or powder is dispersed in a liquid medium which gels on drying. This dispersion is sprayed on to a heated pre-coated specimen grid and the gelling agent is finally washed off. A.

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.319

3084. The stresses and strains in a partly plastic thick tube under internal pressure and end-load. D. N. DE G. ALLEN AND D. G. SOPWITH. *Proc. Roy. Soc. A*, **205**, 69–83 (*Jan.* 22, 1951).

Reviews the solutions for the stress distribution in a thick tube subjected to an internal pressure sufficient to cause yield at the interior, and presents an analysis making rather fewer assumptions; this is developed into a form suitable for practical application. The main defect of this analysis is the assumption (also made in all but one of the other solutions) that the strains at any stage depend only on the stress system

then prevailing and not on how that stress system is reached. The only solution not open to this criticism is a graphical one, not capable of presentation in general form; a comparison of the results by this and the present solution in a particular case shows that the differences are insignificant. The strains are also evaluated, and it is shown that for open-end conditions Cook's assumption that the axial stress is the mean of the radial and circumferential stresses leads to values of the exterior expansion which are not seriously in error. A.

539.319

3085. A mechanical determination of biaxial residual stress in sheet materials. R. G. Treuting and W. T. Read, Jr. *J. Appl. Phys.*, **22**, 130–4 (*Feb.*, 1951).

A method is given for determining the residual stress in a sheet material by removing successive uniform layers of material from the surface of a test specimen and measuring the resulting curvature. From the condition of equilibrium of a free specimen, a stress *v.* curvature relation is derived which holds over the depth to which material has been removed. The method applies when the stress is constant in the plane of the specimen and varies through the thickness. An experimental technique is described which is believed to satisfy the essential requirement that the removal of surface layers should not affect the stress in the remaining material, and a practical example is given. A.

539.32

3086. An optical extensometer. K. R. Chaudhari. *J. Univ. Bombay*, **19**, 13–18 (*Nov.*, 1950).

539.32

3087. The variation of the elastic modulus of quartz lamina as a function of thickness. A. de Gramont. *C.R. Acad. Sci., Paris*, **231**, 1186–8 (*Nov.* 27, 1950) *In French.*

Lamina cut || to the optic axis and ⊥ to one of the electric axes are supported on knife edges, 8 mm apart. When loaded (0·02–5·00 g), the radius of curvature, together with the dimensions of the test piece give the appropriate modulus. Treatment of the lamina with ammonium bifluoride reduces the thickness by about 1 μ. The modulus increases as it is reduced in this manner, but if effected by mechanical polishing the modulus decreases for range (98–50 μ).

J. E. CAFFYN

539.32

3088. A calculation of the elastic constants of aluminium. R. S. Leigh. *Phil. Mag.*, **42**, 139–55 (*Feb.*, 1951).

The elastic constants which correspond to pure shears without change of volume are calculated, and an explanation is given for the fact that Al crystals are almost elastically isotropic. Conclusions are drawn about the nature of the density of states near the Fermi surface, and it is shown how the elastic constants may be expected to depend on electron concentration in Al solid solutions. A.

539.32 : 534.321.9 : 548.0

3089. Elasticity of piezo- and ferro-electric crystals. F. Jona. *Helv. Phys. Acta*, **23** (*No.* 6–7) 795–844 (1950) *In German.*

The elastic constants, determined from diffraction patterns of crystals vibrating at high frequency [Schaefer–Bergmann method, see Abstr. 5343 (1950)] are given for Rochelle salt, KH_2PO_4 and $NaClO_3$ at temperatures between -50 and $+30$°c and for RbH_2PO_4 at 10°c. A theoretical argument shows that the Schaefer–Bergmann method gives the elastic constants at constant electric field and not at constant dielectric displacement. Theoretical explanations are given of various anomalies which appear in the diffraction patterns of these crystals.

H. J. H. STARKS

539.32 : 548.0

3090. Elastic constants of orthorhombic sulphur. R. V. G. Sundara Rao. *Proc. Indian Acad. Sci. A*, **32**, 275–8 (*Oct.*, 1950).

The elastic constants of single crystals of orthorhombic S have been determined by the ultrasonic method. The values in units of 10^{11} dynes/cm^2 are: $C_{11} = 2{\cdot}40$, $C_{22} = 2{\cdot}05$, $C_{33} = 4{\cdot}83$, $C_{44} = 0{\cdot}43$, $C_{55} = 0{\cdot}87$, $C_{66} = 0{\cdot}76$, $C_{31} = 1{\cdot}59$, $C_{23} = 1{\cdot}71$, $C_{12} = 1{\cdot}33$. A.

539.373

3091. Factors controlling dislocation widths. A. J. Foreman, M. A. Jaswon and J. K. Wood. *Proc. Phys. Soc., Lond., A*, **64**, 156–63 (*Feb.*, 1951).

The work of Peierls and Nabarro is extended to a family of edge dislocations of greater widths. The weaker the shearing forces between adjacent atoms in the slip plane, the wider is the dislocation. The external shear stress required to move the dislocations is extremely sensitive to the width, becoming vanishingly small at widths of the order of three atomic spacings. The theory is applied to bubble raft dislocations, and satisfactory agreement is found with experiment. A.

539.373 : 548.0

3092. The law of constant resolved shear stress in crystal plasticity. F. R. N. Nabarro. *Phil. Mag.*, **42**, 213–14 (*Feb.*, 1951).

The formula of Peach and Koehler for the total force acting on a dislocation in a stressed crystal is derived by the use of a theorem due to Colonnetti. The same method distinguishes conservative motions of the dislocation, which do not alter the volume, from other motions. The component of the total force which produces conservative motions acts in the glide plane, and is proportional to the same component of the total stress as appears in the law of resolved shear stress discovered experimentally by Schmid. A.

539.374

3093. On the discontinuous elongation of aluminium crystal. I. T. Kawada. *J. Mech. Lab., Tokyo*, **4** (*Spec. No.*) 26–31 (*March*, 1950).

Commercial Al at 200°c and at a tensile speed of 5 μ/sec gives a stress-strain curve smooth for polycrystals, and fluctuating for single crystals (up to 10% elongation for various orientations). The amplitude of fluctuation was $< 0{\cdot}5\ \mu$. For coarse-grained polycrystal the curve is smooth below the critical shear stress, then discontinuous up to about 10% with the average jump $> 1{\cdot}0\ \mu$, then smooth again. An examination of the distribution and magnitude of jumps has been made together with a

study of the effect of the following factors: components of the test apparatus; temperature; tensile speed; different orientation of crystals in a bicrystal; crystal size; purity and alloying (Al–Zn and Al–Sn alloys). A. J. KENNEDY

539.374

3094. A phenomenological theory of visco-elastic behaviour. I. D. TER HAAR. *Physica*, **16**, 719–37 (*Sept.*, 1950).

Recently, Sips [*J. Polymer Sci.*, **5**, 69 (1950)] has studied the behaviour of visco-elastic substances, starting from a well-defined model, consisting of parallel Maxwell elements. The present series of paper applies Sips's method to a number of simplified models, and discusses for these models the relationship between various methods of measurement. A.

539.374

3095. A phenomenological theory of visco-elastic behaviour. II. D. TER HAAR. *Physica*, **16**, 738–52 (*Sept.*, 1950).

The general theory (see preceding Abstr.) is applied to experimental results. The influence of the finite period of stretching prior to a relaxation or creep experiment and the physical meaning of the relaxation spectrum function $N(\nu)$ are discussed. An approximate method for obtaining a rough impression of the relaxation spectrum from relaxation experiments is described and compared with the approximate method proposed by Alfrey. Relaxation spectra from experimental data of various authors are determined and various methods of exactly obtaining the relaxation spectrum compared. The yield value and the question of non-linear elements and the phenomenon of the glass-transition region are discussed. A.

539.374

3096. The distribution of plastic deformation in a sample of iron under tension, showing the Piobert–Luders effect. M. MOUFLARD AND P. LACOMBE. *C.R. Acad. Sci., Paris*, **231**, 1500–2 (*Dec.* 18, 1950) *In French.*

On increasing the tension beyond a certain limit, giving say $a\%$ elongation, the sample no longer deforms uniformly; it is crossed by bands in which the elongation is $b\%$, a considerably greater amount. The effect of an increase in tension is to broaden these bands, thus causing an overall elongation of between $a\%$ and $b\%$. When the total elongation reaches $b\%$, i.e. the bands occupy the whole sample, further increases in tension produce a uniform elongation. N. CORCORAN

539.374

3097. On the theory of plastic deformation. D. KUHLMANN. *Proc. Phys. Soc., Lond., A*, **64**, 140–55 (*Feb.*, 1951).

A model for plastic deformation in soft metals, i.e. metals which are not age-hardened or severely cold-worked, is given. It is based on the assumption that in real crystals there is always a number of regions present which, by an unknown process, act as sources of dislocations. Furthermore, it is assumed that in soft metals dislocations are very mobile except in a limited number of regions which act as obstacles. The model is applied to explain a number of facts connected with plastic deformation. A.

539.374 : 537.311.33

3098. Plasticity and conductivity, analogous flow phenomena in copper alloys. R. S. FRENCH. Letter in *J. Appl. Phys.*, **22**, 105–6 (*Jan.*, 1951).

A quantitative correlation between these two phenomena, as affected by the presence of solute atoms of Zn, Sn, Ni, Al and Si, is demonstrated.

539.382

3099. A theory of the dynamic plastic deformation of a thin diaphragm. G. E. HUDSON. *J. Appl. Phys.*, **22**, 1–11 (*Jan.*, 1951).

The theory presented in this article was developed in an attempt to describe the observed motion and plastic deformation of clamped metal diaphragms used in certain underwater explosion experiments and in certain mechanical gauges. The theoretical attack on this problem enables one to set up certain equations of motion, which may be solved in finite form under certain conditions. The solutions enable one to specify, for instance, the final deformed diaphragm profile, the distribution of thickness after deformation, the swingtime, which is the total time for deformation to take place, and many other quantities. The simplest case, termed the "elementary approximation," turns out, except for relatively minor details, to describe adequately for many purposes the motion and final shape of the diaphragm; it is found that the deformed diaphragm shape is conical, the thickness distribution shows a marked dimpling at the centre of the diaphragm, and the swing-time t_S is, to this order of approximation $t_S = a/c$, where a is the radius of the diaphragm, and c is the square root of the ratio of the "yield stress" to the density. These results are all in good agreement with experimental facts. A.

539.4.011.22 : 539.26

3100. The elastic limit as established by X-ray analysis. B. M. ROVINSKIĬ AND N. V. TYZHNOVA. *J. Tech. Phys., USSR*, **20** (*No.* 6) 676–82 (*June*, 1950) *In Russian.*

Investigation of specimens of carbon-steels 45 and 15 in simple tensile stressing verified that the surface layer of the metal in the elastic zone does not yield prematurely; the elastic limit of the surface layer exactly coincides with that of the specimen as a whole. Nor was premature yielding detected on a specimen with a rough surface, the protrusions of which were of the order of magnitude of the penetration depth of the X-rays. When the elastic limit is exceeded by the specimens, this affects the surface layer likewise and is marked by a reduction of the elastic deformation. It was found that the ratio of the lattice deformation to the normal component of the elastic deformation of the specimen, $\varepsilon_R/\varepsilon_Z$, or the ratio of the X-ray stresses to the stresses applied to the specimen, σ_R/σ_M, is determined by the material of the specimen and the micro-relief of its surface.

B. F. KRAUS

539.4.016 : 661.1.037.5

3101. The physical aspect of glass-metal seals in the electron tube industry. III. G. TRÉBUCHON AND J. KIEFFER. *Ann. Radioélectricité*, **5**, 407–18 (*Oct.*, 1950) *In French.*

Using materials and techniques described earlier [Abstr. 8396 (1950), 1552 (1951)] the influence on

glass-metal joints of shape, the atmosphere and thermal shocks is discussed. An estimate is given of the permissible practical stress in such joints and the scope of the authors' methods is reviewed.

R. O. DAVIES (R)

539.4.016.3

3102. On the behaviors of metals during rapid heating and rapid cooling. III. S. SAKUI AND K. SATO. *J. Sci. Res. Inst., Tokyo*, **44**, 173–85 (*Oct.*, 1950).

See Abstr. 5762 (1950) and *ibid.*, 139–50 (*June*, 1950) for previous parts. The effects of rapid heating and rapid cooling on the ferrite grain size in pure Fe after recrystallization or transformation were investigated and the results were compared with the change of grain size of C steel on the similar heat treatment. The effect of cooling rate through the transformation range on the grain size of rapidly heated pure Fe was also studied. The changes of structures of hypereutectoid steels heated to various temperatures with the extremely high rates of heating were observed. A.

539.4.019.1 : 666.1/.2

3103. Erratum: Erratum to mechanical properties of glass. F. W. PRESTON. *J. Appl. Phys.*, **22**, 48 (*Jan.*, 1951).

States that velocity of sound in glass was correct as given in original paper [Abstr. 752 (1943)], the 2nd paragraph of erratum [Abstr. 651 (1951)] having been added in error.

539.43

3104. The question of the formation of fatigue microcracks. G. V. KARPENKO. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 1) 95–8 (1950) *In Russian.*

The adsorption theory of stress relief in solid bodies developed by Rebinder *et al.* is applied to explaining the formation of fatigue microcracks. The higher the surface-energy of a solid body the more difficult it is for new microcracks to develop; accordingly the fatigue limit is high. Surface active agents, however, lower the surface energy and therefore facilitate the formation of microcracks. This is confirmed experimentally by submitting steel samples to fatigue tests in the presence of (*a*) inactive vaseline, (*b*) vaseline + 2% isoamyl alcohol, and (*c*) vaseline + 2% oleic acid. The different mechanical treatments of bodies determine the ultramicro-geometry of the surfaces and give rise to different surface-energy distributions and therefore to different conditions for the formation of microcracks, this must be taken into consideration when choosing suitable surface-active agents for different treatments. W. HUGHES

539.62

3105. Types of process of deterioration in dry friction conditions. I. V. KRAGELSKIĬ AND E. M. SHEVETSOVA. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 681–3 (1950) *In Russian.*

Three main types of the reciprocal interaction of materials are distinguished: reciprocal attraction of the molecular fields of the surfaces; molecular seizure of neighbouring surfaces; reciprocal intrusion of those portions of the surfaces which are in contact. Photographs illustrate such types of surface deterioration. The deterioration of steel is shown graphically as dependent on the speed of friction at different pressures and the variation of compression distortions as functions of velocity is also graphically illustrated for heating effect and for "burrowing" effect in metals. J. CLEUGH

539.62

3106. On the friction of various synthetic and natural rubbers on ice. P. M. PFALZNER. *Canad. J. Res., F.*, **28**, 468–89 (*Dec.*, 1950).

The dynamic and static friction on ice, the hardness, and the resilience of natural and synthetic rubber tyre compounds were measured. General relationships were found to exist between friction and hardness of the rubber, friction and ice temperature, hardness and temperature, hardness and age of the rubber, resilience and hardness. Extraction of the rubber had a variable effect. A.

539.62

3107. Dry metallic friction as a function of temperature between 4·2°K and 600°K. I. ŠIMON, H. O. MCMAHON AND R. J. BOWEN. *J. Appl. Phys.*, **22**, 177–84 (*Feb.*, 1951).

Coefficients of static friction of six metals (Fe, Ni, Cu, Pb, Sn and Zn) have been measured at temperatures ranging from liquid He up to room conditions (and in two cases above this). Shear strengths and hardnesses of these metals were measured over the same range of temperatures. It was found that in spite of the generally large variation of both of these latter quantities with temperature, their ratio is in most cases dependent, to only a slight extent, on temperature, following rather closely the change of the static-friction coefficient with temperature. This fact tends to substantiate the adhesion theory of friction proposed by F. P. Bowden. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.121/.124

3108. Some aspects of the chemical statics and dynamics of proteins in solution. E. A. MOELWYN-HUGHES. *Proc. Roy. Soc. A*, **205**, 60–8 (*Jan.* 22, 1951).

Equilibrium constants governing certain reversible changes in structurally simple proteins are formulated by the method of partition functions, adopting as a model for the protein molecule a regular cylinder, capable of cleavage, partial or complete, about a plane parallel to the base. The types of equilibria considered are: (1) the complete separation into fragments; (2) the conversion of the rigid cylinder into one, the two parts of which are capable of independent rotation about the principal axis; and (3) the isomerism which results when the internal rotator couples firmly in two different positions. By

means of the method of imaginary frequencies, expressions are derived for the corresponding velocity constants. A.

541.123.2

3109. The mutual solid solubilities of potassium chloride and potassium bromide. W. E. WALLACE AND M. A. FINEMAN. *Comment. Phys. Math., Helsingf.*, **14** (*No.* 6) 10 *pp.* (1950).

Attention is called to the fact that the phase diagram computed by Fontell to describe the mutual solid solubility of KCl and KBr is in disagreement with solubility and X-ray diffraction experiments. By recalculation of Fontell's data with an equation which, according to the Gaussian criterion for closeness of fit, more satisfactorily represents his data, a new phase diagram was obtained. The new phase diagram is not in conflict with experiment. A.

541.123.2

3110. Vaporization equilibria and heats of admixture in the systems cyclohexane–*n*-heptane and methylcyclohexane–*n*-heptane. J. L. CRÜTZEN, R. HAASE AND L. SIEG. *Z. Naturforsch.*, **5a**, 600–4 (*Nov.*, 1950) *In German.*

The system *cyclo*hexane–*n*-heptane is characterized by strongly positive mixture enthalpy, which, in the region of 20°, is independent of temperature, and also by positive additional entropy (to that of ideal mixtures), as shown by calorimetric measurements and vaporization equilibria data. Between 40°–60°c the additional free enthalpy is so small, through partial compensation of heat and entropy of admixture, that within the accuracy of the measurements now reported no deviations from the Raoult law can be detected. The system methyl*cyclo*hexane–*n*-heptane at 20° also exhibits a positive, but much smaller enthalpy of admixture, which is independent of temperature. From this data, it is thought, on analogy, that many of the binary mixtures now designated as ideal in the literature, are only pseudo-ideal, i.e. ideal at a certain temperature. There are 5 diagrams and 8 references. H. H. HODGSON

541.123.2

3111. Equilibria between solid, liquid and gaseous phases at low temperatures. The binary systems, acetylene carbon dioxide, acetylene ethylene and acetylene ethane. A. M. CLARK AND F. DIN. *Trans. Faraday Soc.*, **46**, 901–11 (*Nov.*, 1950).

The general theory of equilibria between solid, liquid and vapour phases is presented and it is shown how the phase relations of an ideal system can be calculated from the vapour pressures of the components. The effects of deviations from ideal behaviour are qualitatively discussed. Phase diagrams of the three binary systems which have been studied experimentally are based on measurements of vapour pressures and solubility, or freezing-point depression. A.

541.123.5

3112. Studies on the mechanism of some chemical reactions by means of radio-sulphur. R. MUXART. *C.R. Acad. Sci., Paris*, **231**, 1489–91 (*Dec.* 18, 1950) *In French.*

When studying the reaction $SO_3HCl + SCl_2 = SOCl_2 + SO_2 + HCl$, it has been shown that there is no exchange of S either between SO_2 and $SOCl_2$ or between SO_2 and SCl_2, while there is such an exchange between $SOCl_2$ and SCl_2. Reference is made to a paper by Muxart *et al.* (*J. Chim. Phys.*, **46**, 9–10 (1949)], and it seems that reactions of this kind take place only when they can be explained by a transfer of oxygen. F. LACHMAN

541.123.6

3113. Quaternary equilibria data. A. V. BRANCKER. Letter in *Nature, Lond.*, **166**, 960–1 (*Dec.* 2, 1950).

541.124

3114. Kinetics of the isotopic exchange reaction between carbon monoxide and carbon dioxide. T. H. NORRIS and S. RUBEN. *J. Chem. Phys.*, **18**, 1595–1600 (*Dec.*, 1950).

The rate of this reaction has been studied with C^{14} as a tracer. The reaction, whose velocity in a quartz vessel is convenient for study between 800 and 900°c appears to follow the rate law: Rate = $k(pCO)^{0\cdot73}(pCO_2)^{0\cdot85}$. The apparent activation energy is 77 kcal. The reaction is accelerated by added N but not A. Packing increases the rate only slightly, giving no indication of a primarily heterogeneous reaction. However, this observation is considered questionable. The present conclusions differ somewhat from those derived by Brandner and Urey from a similar investigation. Re-examination of these authors' data seems to resolve the apparent inconsistencies. It is concluded that their proposed reaction mechanism is invalid; however, their conclusion of heterogeneity seems more acceptable. A probable mechanism appears to be a bimolecular exchange between the two reactants adsorbed on the catalytic surface. The acceleration by N or, as observed by Brandner and Urey, by H or water is then possibly to be ascribed to "promotion" of the catalyst by surface adsorption of these substances. A.

541.126

3115. A study of slow self-propagating reactions in solids. R. A. W. HILL, L. E. SUTTON, R. B. TEMPLE AND A. WHITE. *Research, Lond.*, **3**, 569–76 (*Dec.*, 1950).

The self-propagation of slow reactions in mixtures of oxidizing and reducing agents has been studied by recording the temperature changes as the reaction front passes a point. The results have been used: (1) to investigate the stoichiometry of the reactions, (2) to test the Mallard–Le Chatelier theory of propagation by thermal conduction, (3) to obtain rates and activation energies for the burning reaction. This theory appears to be essentially correct, though somewhat inadequate in its simple form. A.

541.126 : 535.338

3116. Kinetics of OH radicals from flame emission spectra. II. Rotational and vibrational distribution functions and temperature determinations in the $^2\Sigma^+ - {}^2\Pi$ transition of OH. K. E. SHULER. *J. Chem. Phys.*, **18**, 1466–70 (*Nov.*, 1950).

Rotational and vibrational distribution functions for a rotating oscillator are developed for a steady state with non-equipartition of energy such as might be found for electronically excited species in a flame. Methods are described for the separate spectroscopic determination of rotational and vibrational equilibria

and "temperatures" for the case of thermal equilibrium and for the case of a non-equipartition distribution of energy. These methods are applied to the study of electronically excited OH radicals in an equimolar oxy-natural gas (88% CH_4) flame. Rotation-vibration equilibrium with a rotation-vibration temperature of ~2 550°K was found. Analysis of the data indicates that the vibrational transition probabilities for the $^2\Sigma^+ - {}^2\Pi$ transition calculated in Part I (Abstr. 1392 (1951)] are accurate to about the 10% claimed in that communication. A.

541.126 : 536.531

Some extensions in the use of resistance thermometry in the study of gaseous explosions. *See Abstr.* 2638.

541.127

3117. II. The reduction of SrO by tungsten in vacuum. G. E. Moore, H. W. Allison and J. Morrison. *J. Chem. Phys.*, **18**, 1579–86 (*Dec.*, 1950).

It is shown that in the temperature range 1 150–1 550°K, SrO is reduced by W in vacuum. Both the rate of the reaction and its equilibrium constant can be calculated, giving values in substantial agreement with the experiments, which were performed under conditions such that both could be measured. The use of radioactive isotopes simplified the experimental work. A.

541.127

3118. A discussion on detonation: Introduction to the discussion. W. G. Penney. *Proc. Roy. Soc. A*, **204**, 1–8 (*Nov.* 22, 1950).

A review of the advance in understanding of the detonation process during and since the recent war. Much effort has been devoted to a study of the structure of the detonation zone; this work is discussed with emphasis on the light thereby thrown on the condition, empirically discovered by Chapman and Jouguet, defining the condition of the reacted products immediately behind the detonation wave. The detonation zone is regarded as consisting of 2 parts —a shock front 10^{-5} cm thick followed by a reaction zone whose thickness varies between 0·1 and 1 cm for military explosives, and may be up to 10 m for dust explosions. Behind the reaction zone, the reacted products expand adiabatically in a manner dependent on the boundary conditions in this region; this subsequent expansion sets up rarefaction waves travelling towards the detonation zone with the local velocity of sound. A steady state is only possible when such rarefaction waves cannot penetrate into the reaction zone; the gas velocity relative to the detonation front must therefore be sonic at the rear of the reaction zone. The subdivision of the detonation zone into shock front and reaction zone is realistic for dust explosions and satisfactory for military explosives, but it is only justifiable for gaseous detonations if translational and rotational degrees of freedom are excited and reach equilibrium before other modes; if this is not so, the shock front and reaction zone may be merged into one region of thickness 10^{-4} to 10^{-5} cm. Other topics briefly discussed include the effect of diameter of a cylindrical stick of explosive on its velocity of detonation, the motion of the fluid surrounding a detonating explosive, non-steady detonation and non-planar detonation waves.

A. SCHOFIELD

541.127

3119. A discussion on detonation: Similarity solutions to problems involving gas flow and shock waves. G. Taylor. *Proc. Roy. Soc. A*, **204**, 8–9 (*Nov.* 22, 1950).

In studying the flow of the reacted products behind the detonation zone, it is usual to start from the general equations of motion of compressible gases and shockwaves, and then to limit their generality by successive simplifying assumptions to facilitate mathematical analysis and to allow their formal solution. Among the simplifications thus introduced are usually assumptions about the geometry of the flow-field, which produce important elements of symmetry. It is pointed out that an alternative method of approach is to introduce the symmetry assumptions at the beginning of the calculation, to guess the form of solution having this symmetry, and subsequently to prove that this guess was correct. Problems solved in this way by the author include the field of flow behind a detonation front when detonation originates instantaneously at a point within the explosive, the detonation of an explosive in a tube which expands under gas pressure, and the blast wave from an intense explosion. A. SCHOFIELD

541.127

3120. A discussion on detonation: Theoretical considerations relating to the detonation of solid explosives. H. Jones. *Proc. Roy. Soc. A.*, **204**, 9–12 (*Nov.* 22, 1950).

Theoretical treatment of detonation in solid explosives is made difficult by the fact that little is known about the equation of state of the reacted products. It is usual to assume an equation of state containing several arbitrary parameters, and to choose the numerical values of these parameters to fit the observed variation of detonation velocity U with loading density ρ for some given explosive. In this way an interdependent estimate of the pressure, density and temperature at the detonation front may be obtained. An alternative procedure is described which gives an estimate of the pressure p independent of any assumption regarding the equation of state: this is given by the formula $p = U^2\rho/(2 + \alpha)\left[1 + \frac{\rho}{U}\frac{dU}{d\rho}\right]$ where α is necessarily positive and its value is approx. 0·2. The value of α depends on the equation of state and therefore its value is subject to some uncertainty, but even if it is in error by 10% the detonation pressure deduced from the above equation will be accurate to 1%. A second factor which must be allowed for is lateral expansion of the reacting gases whilst they are in the reaction zone. Because of this expansion U depends on the ratio l/R, where l is the reaction-zone length and R the charge radius. By calculating the functional relationship between U and l/R, the reaction-zone length may be deduced from the observed dependence of U upon R. A. SCHOFIELD

541.127

3121. A discussion on detonation: The reduction in reaction energy in cases of incomplete confinement. S. Paterson. *Proc. Roy. Soc. A*, **204**, 30 (*Nov.* 22, 1950).

Commenting on the paper by Jones (preceding Abstr.) the author draws attention to the fact that

when an explosive charge is imperfectly confined, part of the chemical reaction may take place outside the region in which conditions remain unchanging from the point of view of an observer accompanying the wave. This may have an effect on the detonation velocity comparable in importance with that of the overall reduction in pressure considered by Jones.

A. SCHOFIELD

541.127

3122. A discussion on detonation: Some characteristics of detonation. W. M. EVANS. *Proc. Roy. Soc. A*, **204**, 12–17 (*Nov.* 22, 1950).

Methods of measuring velocity of detonation are reviewed and factors which influence the velocity of detonation of solid explosives are discussed. The original method developed by Dautriche, in which the velocity is compared with that of a standard explosive whose detonation velocity is assumed constant and known, is still in use for routine measurements; but for more accurate fundamental investigations the progress of the detonation wave is recorded photographically, using a rotating mirror camera with a writing speed of up to 1 mm/μsec. The light emitted by some detonating explosives is too weak to give a satisfactory photograph, and various means of overcoming this difficulty have been devised. In particular, the luminosity of the air-shock accompanying the detonation wave may be enhanced by encasing the charge in a transparent envelope. Spurious results may be obtained by this technique if the motion of the air-shock does not exactly reproduce that of the detonation wave; this may happen if the detonation velocity is not steady. The photographic technique has been applied to an examination of the transition of a detonation wave across an interface between 2 solid explosives; to eliminate spurious surface effects the arrival of the wave at the bottom of a series of holes in the charge was recorded; the holes were either radial, viewed broadside on to the charge, or parallel with the axis along which the charge was viewed. It was found that for some explosive combinations the transition from one steady velocity to another (a change of about 3 000 m/sec) was accomplished within a few mm, but in general the transition occupies several cm. The mechanism of the transition is not fully understood. A. SCHOFIELD

541.127

3123. A discussion on detonation: The initiation of an explosion and its growth to detonation. F. P. BOWDEN. *Proc. Roy. Soc. A*, **204**, 20–5 (*Nov.* 22, 1950).

Experiments are described which indicate that the cause of initiation by friction or impact is the formation of hot spots of small but finite size from which thermal ignition proceeds. The diameter of these hot spots may be 10^{-5} to 10^{-3} cm. It is shown that their temperature must exceed 400–500°C. When, for example, nitroglycerine is rubbed between 2 materials whose melting-points < 450°C explosions never occur, but explosions do occur if the m.p. > 480°C. A similar result was obtained by incorporating fine particles of impurities into the explosive; only those having a m.p. > 430°C sensitized the explosive. High-speed streak photographs show that thermal ignition of entrapped vapour leads first to rapid burning, then to a low-order detonation, accelerating to normal steady detonation. Exceptions to this general behaviour have been noticed. Sometimes the wave may pass through the early stages without developing into a steady detonation wave; while in the case of some primary explosives like Pb azide the period of rapid burning appears to be absent, and detonation sets in at once. It is suggested that "hot-spot" initiation must play an essential part in the mechanism of steady propagation of low-order detonation, as bulk heating by shock wave compression could not, at these low velocities, raise the temperature of the explosive by > 40°C.

A. SCHOFIELD

541.127

3124. A discussion on detonation: High and low detonation velocity regimes in condensed explosives. J. TAYLOR. *Proc. Roy. Soc. A*, **204**, 30–1 (*Nov.* 22, 1950).

For many years it has been known that some liquid and gelatinous explosives are capable of detonating steadily at either of two velocities depending upon the strength of initiation; heavy priming gives velocities around 7 000 m/sec and relatively weak priming about 2 000 m/sec. Intermediate steady velocities are never obtained, but in large dia. charges only high-velocity propagation is possible. It is difficult to explain the existence of two regimes on the basis of the ordinary hydrodynamic theory of detonation, and it is suggested that the mechanism of decomposition of the explosive in the two cases is quite different. The low-velocity regime may be explainable by deflagration on the surface of grains or films, initiated at hot-spots produced by heating of interstitial gases, and the high-velocity regime by bulk thermal decomposition. A. SCHOFIELD

541.127

3125. A discussion on detonation: The fading of detonation in solid explosives. O. A. GURTON. *Proc. Roy. Soc. A*, **204**, 31–2 (*Nov.* 22, 1950).

A coarse-grained explosive at low density may be set off at a velocity greater than its stable velocity by a number of priming charges, in some of which the detonation velocity is greater than the initial velocity of the explosive, and some which detonate at a lower speed. Experiments using ballistite at a density of 1·05 gm/cc are described, in which (for charges $\geqslant 1$ in dia.) the detonation velocity falls steadily from an initial value $> 6\,000$ m/sec to a steady value of approx. 3 500 m/sec over a distance of about 20 cm. For charges of smaller dia. no steady velocity is reached, and detonation fails to propagate. In such cases, however, the deceleration of the detonation wave is not uniform; a point of inflection occurs in the velocity-decay curve corresponding to the stable velocity to be expected. A. SCHOFIELD

541.127 : 531.78

3126. A discussion on detonation: Pressure measurements in detonating gases. R. M. DAVIES, J. D. OWEN, D. H. EDWARDS AND D. E. THOMAS. *Proc. Roy. Soc. A*, **204**, 17–19 (*Nov.* 22, 1950).

A new pressure-bar technique: The Hopkinson pressure-bar suffers from the inherent disadvantage

that longitudinal elastic waves in a bar show dispersion, and consequently stress-pulses are distorted. Torsional waves in a circular cylinder do not suffer dispersion: advantage has been taken of this fact by the authors in designing a pressure-bar in which the applied pressure is used to excite torsional waves. The angular displacement of a polished optical flat on the surface of the bar is recorded photographically using a rotating mirror camera with a writing speed of about 4 mm/μsec. It has been found that the pressure rise caused by impact of a flat-headed lead bullet takes place in < 1 μsec when observed with a torsion bar, as against > 5 μsec using a Hopkinson bar.

Preliminary results with measurements of pressures in detonating gases: Gaseous mixtures were detonated in a steel explosion tube 12 ft long and 1·25 in square section; the static pressure was measured by gauges flush with the side wall of the tube, and the reflection pressure by a gauge flush with the closed end of the tube. Three types of gauge were used: (*a*) quartz piezo-electric, (*b*) Hopkinson pressure-bar with parallel-plate condenser unit, (*c*) Hopkinson pressure-bar with resistor strain unit. It was found that, although the pressure-bar is subject to errors caused by dispersion, the results were more accurate than those from the piezo-electric gauge, which suffers from uncertainties due to gauge oscillations. Comparison of the experimental results with theoretical values for C_2H_2–O_2 and H_2–O_2 mixtures shows fairly good agreement in the case of static pressures, but the measured reflection pressures are lower than the calculated values by a factor between 2 and 4. A. SCHOFIELD

541.127 : 550.341

3127. A discussion on detonation: The physical chemistry of detonative reactions. A. R. UBBELOHDE. *Proc. Roy. Soc. A*, **204**, 25–6 (*Nov.* 22, 1950).

It has been shown that the time of energy release in detonating TNT is not sensitive to the temp. in the reaction zone; it therefore follows that the chemical transformations involved do not depend on selective Arrhenius activation processes. It is pointed out that, in principle, a detonation wave could be set up in a material undergoing an exothermic transformation evolving only a small amount of energy per unit vol.; in such a detonation, however, the reaction zone would be extremely broad, and unless detonation takes place over wide areas, or is heavily confined, lateral energy losses would cause the wave to fade. An example of such a weakly detonating explosive is NH_4NO_3, which has only been known to detonate in very large quantities. It is suggested that the setting up of a low-energy-release detonation over a very wide area by polymorphic transitions in molten rock may account for the origin of certain earthquakes. A. SCHOFIELD

541.127 : 778.37

3128. A discussion on detonation: Two new streak cameras. C. A. ADAMS. *Proc. Roy. Soc. A*, **204**, 19–20 (*Nov.* 22, 1950).

The general design of the cameras is described, but no constructional details are given. In the one camera, provision is made for the simultaneous observation of a vertical and a horizontal slit; the image of each slit is traversed along an independent quadrant (track radius approx. 19 in) by means of a $2\frac{1}{2}$ in square-section mirror rotating at 40 000 revs/min. This gives a writing speed on the film of 4 mm/μsec. By means of interchangeable objectives, distances from 20 ft to infinity can be covered; the film width is 90 mm of which 2·75 in is available for recording. The output from a magnetic pickup on the mirror shaft is fed to a tachometer circuit which measures the speed of rotation of the mirror; the same circuit is used to provide the firing impulse which initiates the charge, so ensuring that the record appears on a predetermined portion of the film. In the second camera the laminar rotating mirror ($1\frac{1}{2} \times 1 \times 0{\cdot}1$ in) is driven by compressed air at a speed of 80 000 revs/min giving a writing speed of 6·5 mm/μsec. Tachometer and synchronization are similar to those of the first camera, but an additional timing device in the form of 3 spark gaps inside the camera body, triggered at known intervals during the recording period, is provided. A. SCHOFIELD

541.127 : 778.37

3129. A discussion on detonation: A new photographic method for studying fast transient phenomena. J. S. COURTNEY-PRATT. *Proc. Roy. Soc. A*, **204**, 27–9 (*Nov.* 22, 1950).

An optical image of the object under examination is formed on the photosensitive cathode of an image convertor tube; the cathode emits a corresponding electron stream which is focused on a fluorescent screen by means of an electron lens system, and the screen is photographed by a stationary camera. If an electric or magnetic field is introduced to act on the electron stream between the electron lens system and the screen, the image on the screen can be rapidly displaced. A record similar to that from a rotating mirror camera is obtained if the cathode image is restricted to a narrow slit; but the elimination of mechanically moving parts permits much higher writing speeds to be used, and the absence of vibration results in better definition. By this method writing speeds of 100 mm/μsec have been attained, with a time resolution better than 10^{-9} sec. Using this camera a study has been made of the initiation of Pb azide; it has been shown that there is no period of rapid burning, but a detonation wave at a velocity of 2 000 m/sec is set up within a few mm of the point of initiation. This type of camera may also be used to take single photographs by applying a short voltage pulse to a control electrode; the exposures are as short as is possible with flash photography or Kerr cells, and do not suffer from the light loss associated with the latter. A. SCHOFIELD

541.127 : 778.37

3130. A discussion on detonation: Some comments on the contribution by Dr. Courtney-Pratt. A. R. UBBELOHDE. *Proc. Roy. Soc. A*, **204**, 29–30 (*Nov.* 22, 1950).

See preceding Abstr. It is pointed out that less direct methods of examination of the initiation of Pb azide lead to the conclusion that when lead azide is initiated in air there is no preliminary stage of rapid burning; but when the air is replaced by a liquid of high boiling-point, Pb azide may be initiated by a

thermal, self-heating process. It is suggested that it would be valuable to confirm this by the photographic technique. A. SCHOFIELD

541.128 : 537.212

3131. Electromagnetic fields as catalysts. K. EISEMANN. Letter in *J. Phys. Coll. Chem.*, **54**, 1385 (*Dec.*, 1950).

Investigation of the influence, if any, of strong electric fields (steady and alternating) on the physical properties of substances is suggested, since the decreased stability of molecules caused by induced dipole electron shifts raises the possibility of the use of strong electromagnetic fields as catalysts for chemical reactions. H. H. HODGSON

541.128.12

3132. Kinetics of the reaction of atomic hydrogen with acetylene. J. R. DINGLE AND D. J. LE ROY. *J. Chem. Phys.*, **18**, 1632–7 (*Dec.*, 1950).

A study has been made of the rate of recombination of atomic H in the presence and in the absence of the homogeneous catalyst, acetylene. The recombination in the absence of acetylene has a negative temperature coefficient and an order between 1 and 2. The acetylene-catalysed recombination was found to be 1st-order in atomic H and 1st-order in acetylene, with a rate constant of $1 \cdot 3_4 \times 10^{-14}$ cc molecules^{-1} sec^{-1} at 17°c. The effect of temperature on the reaction corresponded to a collision theory activation energy of 1·5 kcal/mole and a steric factor of 4×10^{-4}. A.

ELECTROCHEMISTRY 541.13

541.13

3133. Revision of the fundamentals of electrochemistry. J. PALACIOS. *Cienc. y Invest.*, **6**, 540–9 (*Dec.*, 1950) *In Spanish.*

The e.m.f. of electrolytic cells is calculated by considering the sum of all possible p.d. It is shown that the e.m.f. of a voltaic pile equals the voltaic p.d. between its electrodes plus the galvanic potential which the electrolyte and the gaseous phase produce in the potential barriers of both electrodes. The galvanic potential is not equal to the value of the voltaic potential. W. SUMMER

541.132 : 534.321.9

The measurement of ultrasonic vibration potentials (Debye effect) with pulse techniques. *See Abstr.* 2476

541.132.3

3134. *p*H standards of high acidity and high alkalinity and the practical scale of *p*H. R. G. BATES, G. D. PINCHING AND E. R. SMITH. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 418–29 (*Nov.*, 1950).

The practical scale of *p*H is defined in terms of the electromotive force of the galvanic cell Pt; $H_2(g)$, solution|satd. KCl|standard, $H_2(g)$; Pt. This potential is usually obtained as the difference of two electromotive force values for a cell with glass and calomel electrodes, one of which is a calibration with a standard of known *p*H. Appropriate corrections must be applied if the glass electrode does not respond to changes in H-ion activity in exactly the same manner as the H electrode. However, there is no simple means of correcting *p*H measurements for the potential differences at the junctions of the solution and the standard with the solution of KCl. These errors are sufficiently large in highly acid and highly alkaline solutions to render uncertain the interpretation of measured *p*H in these regions, in spite of the fact that reasonably accurate standards of H-ion activity are available at intermediate *p*H values. Methods and results are described relating to (*a*) determination of selection of the extent of aberration of the practical *p*H scale near its end, (*b*) new standards that might improve the accuracy of *p*H measurements and facilitate their interpretation over the entire practical scale, with particular attention to the regions of high acidity and high alkalinity. A.

541.133

3135. Conductivity of liquids and the influence of mixing on dissociation. J. CLAY AND F. VAN DER MAESEN. *Physica*, **16**, 781–91 (*Oct.*, 1950).

The variable-cell measurement of the conductivity of liquids is described. The method is applied to the determination of the specific conductivity of aniline, nitrobenzene, mixtures of the two and of solutions of diethylamine-hydrochloride in the liquids mentioned. The presence of group moments of opposite sign in the solvents (aniline and nitrobenzene) promotes the ionization of this salt. A.

541.133

3136. The electric conductivity of weak electrolytes and ampholytes at high electric field strengths. O. BLÜH AND F. TERENTIUK. *J. Chem. Phys.*, **18**, 1664–8 (*Dec.*, 1950).

An oscillographic method has been devised for the investigation of the variation of the electrolytic conductivity with the electric field strength up to 100 kV/cm. The method has been used to measure the field effect in various weak electrolytes, particularly in ampholytes. A.

541.133

3137. High-frequency conductivity of paraffin-chain salts. R. SCOTT AND T. R. BOLAM. Letter in *Nature, Lond.*, **167**, 195–6 (*Feb.* 3, 1951).

541.133.08 : 537.311.35.08 : 621.317.331

The measurement of electrical conductivity of liquids without electrodes. *See Abstr.* 2693

541.133.1

3138. Anomalous D^+ and OD^- ionic mobility in heavy water. A. GIERER. *Z. Naturforsch*, **5a**, 581–9 (*Nov.*, 1950) *In German.*

Measurements now reported, with experimental details, 5 tables and 5 sets of curves, on the temperature dependence of the conductivity of DCl, NaOD and NaCl in heavy and in mixtures of light and heavy water, indicate an anomalous high mobility for H^+, OH^- and D^+, OD^-, in accord with theoretical anticipation. These anomalies point to a special migration mechanism for protons and deuterons involving H bonds, and influenced by anomalies of water structure. The deviation from linearity of the extra mobility in mixtures of H_2O and D_2O is explained partly by temperature dependence and partly by the introduction of some new independent experimental factors. 12 references. H. H. HODGSON

541.135.2

3139. State of solvation of ions in liquid mixtures. II. Transport measurements for lithium picrate in water-ethanol mixtures. G. KORTÜM AND A. WELLER. *Z. Naturforsch.*, **5a**, 590–9 (*Nov.*, 1950) *In German.*

Data given in previous part [Abstr 1426 (1951)] on the conductivity of lithium picrate in water-ethanol mixtures, together with new data on transport numbers, have enabled calculation of ionic mobilities, and from them of information, now discussed, of their state of solvation. There are 7 tables of data, 7 diagrams, and 24 references. H. H. HODGSON

541.135.2

3140. A mechanical surface effect during spark electrolysis. P. BARRET. *C.R. Acad. Sci., Paris*, **232**, 58–60 (*Jan.* 3, 1951) *In French.*

Data are furnished from the spark electrolyses of a number of solutions of different electrolytes, whose concentrations c have been adjusted so that the conductivities are the same with reference to N.KCl at 18·6° and $\sigma_{18} = 982 \cdot 10^{-4}$ mhos. For continuous or alternating currents, it is found that $\rho \Delta V/q = K(c, t)$, where q coulombs of negative electricity traverse the spark in the direction of solution to external electrode, and V = vol. of solution and ρ its density. For a given electrolyte, K is a function of c and temp. t. H. H. HODGSON

541.135.5

3141. Measuring exchange currents on amalgam electrodes by means of radioactive indicators. N. B. MILLER AND V. A. PLESKOV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 323–5 (1950) *In Russian.*

Results are given for the exchange currents measured on electrodes consisting of liquid amalgams of Bi, Pb and Zn, in contact with solutions of their respective salts. The radioactive isotopes used were: Bi^{210} (RaE, $T_{\frac{1}{2}} = 5$ d), Pb^{210} (RaD, $T_{\frac{1}{2}} = 22$ yr), and Zn^{65} ($T_{\frac{1}{2}} = 250$ d). The exchange currents in strong solutions have for all three amalgams values lying between 0·1–0·04 amp/cm². For smaller concentrations the currents are weaker, and for concentrations $< 0 \cdot 2$N there exists a proportionality between I and c in the case of Zn and Bi. F. LACHMAN

541.135.5

3142. Electrode function (*p*H response), hygroscopicity, and chemical durability of soda-lead oxide-silica glasses. D. HUBBARD, M. H. BLACK AND G. F. RYNDERS. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 430–9 (*Nov.*, 1950).

Glasses of very low hygroscopicity yield electrodes whose *p*H responses fall appreciably below the theoretical 59 mV per *p*H at 25°C; electrodes prepared from glasses of poor chemical durability also fail to develop the full theoretical voltage. When the approximate compositions at which changes in the primary phase appear for the Na_2O–PbO–SiO_2 system are superimposed upon the *p*H response and chemical durability curves, the marked changes in these properties appear to reflect some of the critical compositions of the phase-equilibrium diagram. The chemical durability data obtained by the interferometer procedure indicate that the property of swelling in acid solutions is much more universal for silicate glasses than previously realized. A.

541.135.5

3143. Distribution of current in porous electrodes. J. J. COLEMAN. *J. Electrochem. Soc.*, **98**, 26–30 (*Jan.*, 1951).

An experimental test is made of the applicability of Kirchhoff's law to porous electrodes. The theory is applied to a dry cell made with 3 bodies of mix separated from each other by paper walls wet with electrolyte. The 3 bodies are thus isolated electronically but connected ionically. All 3 are connected to the external load. Thus, the electronic current flowing into each body of mix is equal to the polarizing current in each body and is a measure of the rate of reduction of MnO_2 in each body. It is shown that established theory explains the distribution of current, using two parameters determined directly from the current distribution data. See also *Trans. Electrochem. Soc.*, **90**, 545 (1946). A.

541.135.5 : 534.39

3144. The effect of acoustical radiations on the hydrogen electrode. E. YEAGER AND F. HOVORKA. *J. Electrochem. Soc.*, **98**, 14–20 (*Jan.*, 1951).

Mathematical consideration is given to the production of alternating components in the electrode potential of a H electrode in an acoustical field. The effect is discussed in terms of (*a*) a l.f. region in which the instantaneous conditions are characterized as reversible and (*b*) a higher-frequency region in which relaxation phenomena result because of the lack of instantaneous equilibrium conditions. While the former case involves the use of thermodynamics, the latter requires a kinetic treatment. An attempt is made to relate the reaction constants for the processes at both the reversible and polarized H electrodes to the phase angle and amplitude of the effect throughout a range of frequencies. The effect at h.f. may provide an interesting test for theories of rate processes at gaseous electrodes. A.

541.135.88

3145. Electrolysis of aluminium solutions in a magnetic field. C. E. WOOD AND C. W. TITTLE. Letter in *J. Chem. Phys.*, **18**, 1683 (*Dec.*, 1950).

541.136

3146. Some electrical relations in galvanic couples. H. D. HOLLER. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 373–80 (*Nov.*, 1950).

The electrical relations are developed for a galvanic couple (short-circuited cell) with and without polarization by externally applied current. Their significance in the derivation of criteria for cathodic protection is demonstrated. The mechanism of current flow between couples at different potentials is explained. The importance of galvanic-couple theory in governing current distribution over an electrode surface is indicated. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14

3147. Photoreduction of $FeCl_4^-$ in alcohol. G. J. BREALEY, M. G. EVANS AND N. URI. Letter in *Nature, Lond.*, **166**, 959–60 (*Dec.* 2, 1950).

541.14 : 538.222

3148. Errata: The photo-chemical reduction of water by europium (*II*) ion, and the magnetic susceptibilities of europium (*II*) and europium (*III*) ions. D. L. DOUGLAS AND D. M. YOST. Letter in *J. Chem. Phys.*, **18**, 1687 (*Dec.*, 1950). See Abstr. 3462 (1950).

541.14 : 541.64

3149. The photopolymerization of vinylidene chloride. I. J. D. BURNETT AND H. W. MELVILLE. *Trans. Faraday Soc.*, **46**, 976–96 (*Nov.*, 1950).

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.182.4

3150. On molecular exchange effects in adsorption layers. A. B. TAUBMAN. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 759–61 (1950) *In Russian.*

Using the technique of strongest drop formation pressure, surface activity measurements were taken for higher homologues of fatty acids at the separation surface with water. In contrast with the liquid-vapour boundary, adsorption layers at the separation surface between 2 liquid phases are in a gaseous state, identical with that of lower homologues. Differences in surface activity between a series of homologues are small. The marked decrease of exchange forces at the boundary of 2 liquid phases may be significant in problems of stabilization of emulsions. J. JACOBS

541.182.5 : 534.321.9

3151. Ultrasonic studies of gels. A. M. SRIVASTAVA. *Z. Phys.*, **128** (*No.* 5) 614–16 (1950) *In German.*

The pulse method was used to determine the elastic properties of an iron silicate gel. Curves are given for the variation in Young's modulus with frequency (0·5–2·5 Mc/s) and temperature (27–70°c), and for the variation with time of the shear modulus and shear wave velocity at 30°C. H. J. H. STARKS

541.182.5 : 534.321.9

3152. Ultrasonic studies on gels. A. M. SRIVASTAVA. *C.R. Acad. Sci., Paris*, **231**, 1223–5 (*Nov.* 27, 1950) *In French.*

The elasticities of iron silicate gels have been obtained at freqs. of 0·625, 1·25, 2·25 and 2·50 Mc/s using an ultrasonic pulsation method. Graphs showing variation with temperature and time are given. A theory has been developed to explain the structure and formation of the gel. The ultimate units are groups of atoms forming a fibrous structure with a random orientation. G. F. HODSMAN

541.182.6 : 532.133

Studies of the viscosity and sedimentation of suspensions. *See Abstr.* 2408

541.183

3153. Change with temperature of the heat of wetting of dry cellulose in water, and its bearing on the specific heat of the adsorbed water and of the swollen cellulose. M. WAHBA AND S. NASHED. Letter in *Nature, Lond.*, **166**, 998 (*Dec.* 9, 1950).

541.183 : 530.162 : 536.71

3154. Statistical thermodynamics of critical and surface phenomena. III. A theory of lower critical solution phenomenon. S. ONO. *Mem. Fac. Engng Kyushu Univ.*, **12** (*No.* 2) 201–13 (1950).

See Abstr. 9076 (1950) for part II. Theoretical. By use of partition functions an expression is arrived at which gives the change in free volume with composition for a binary solution. From it the existence of a lower critical solution temperature (T) is deduced. It is recognized, however, that in some systems T may arise from some other cause, e.g. the onset of free rotations of molecules. S. J. GREGG

541.183 : 539.163.4

3155. Chromatographic technology in radioisotope separation. I. Chromatographic equipment; II. Applications. H. WEIL. *Atomics, Lond.*, **1**, 230–4 (*Aug.*); 345–56 (*Dec.*, 1950).

In part I new equipment is reviewed, and an almost continuous separator, with large-scale possibilities, described. In part II separation techniques for the rare earths, the transuranic elements, the natural radioactive elements and others are discussed in detail. Semi-industrial application is emphasized throughout. An extensive bibliography is given. R. H. DAVIES

541.183 : 541.128

3156. Adsorption of hydrogen at elevated pressures on a promoted iron synthetic ammonia catalyst. M. V. C. SASTRI AND H. SRIKANT. Letter in *Curr. Sci.*, **19**, 313 (*Oct.*, 1950).

541.183 : 541.128

3157. Adsorption studies on methanol synthesis catalysts. I. Adsorption of carbon monoxide and hydrogen on zinc oxide-chromium oxide mixture. J. C. GHOSH, M. V. C. SASTRI AND S. VEDARAMAN. Letter in *Curr. Sci.*, **19**, 342 (*Nov.*, 1950).

541.183 : 541.128

3158. Adsorption of nitrogen at elevated pressures on a promoted iron synthetic ammonia catalyst. M. V. C. SASTRI AND H. SRIKANT. Letter in *Curr. Sci.*, **19**, 343 (*Nov.*, 1950).

541.183 : 548.7

Adsorption at "thermal disorders" on crystal surfaces. *See Abstr.* 3197

541.183.1 : 536.7

3159. The thermodynamics of adsorption. II. Thermodynamics of monolayers on solids. D. H. EVERETT. *Trans. Faraday Soc.*, **46**, 942–57 (*Nov.*, 1950).

See Abstr. 7573 (1950) for Part I. A general thermodynamic treatment of adsorption equilibrium is proposed which follows the lines of the thermodynamics of solutions in that the properties of a real system are compared with those of an ideal reference system. For adsorption, two possible reference systems are the ideal localized monolayer and the ideal non-localized monolayer. These are examined and their range of usefulness is discussed generally; their application to experimental data is considered in the following paper of this series. A short discussion is also given of the relation between the present method and the Polanyi potential theory. A.

541.183.1 : 536.7

3160. The thermodynamics of adsorption. III. Analysis and discussion of experimental data. D. H. EVERETT. *Trans. Faraday Soc.*, **46**, 957–69 (*Nov.*, 1950).

An analysis on the lines suggested in Part II preceding Abstr.) is made of published experimental data on the adsorption of gases. It is concluded that the thermodynamics of adsorbed monolayers may be discussed very satisfactorily by employing, as ideal reference system, the ideal localized monolayer model. Non-ideal behaviour arises from deviations of both the heat and entropy of adsorption from the ideal values. A linear relation exists between the non-ideal entropy and the heat of adsorption which for adsorption on charcoal at 0°c is identical with that between heats and entropies of condensation of vapours to pure liquids, or into solution. This relation suggests a method of calculating heats of adsorption from a single adsorption isotherm. The application of the present findings to problems of surface heterogeneity and multilayer adsorption is discussed. A.

541.183.2

3161. On the phase state of the matter in an adsorptive layer. I. E. NEĬMARK AND F. I. KHATSET. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 751–4 (1950) *In Russian.*

541.183.2

3162. Role of capillary condensation in physical adsorption. P. C. CARMAN AND F. A. RAAL. Letter in *Nature, Lond.*, **167**, 112–13 (*Jan.* 20, 1951).

In order to discover whether capillary condensation takes place in addition to multilayer formation in physical adsorption, isotherms have been determined for the adsorption of CF_2Cl_2 on Linde silica as a loose powder, and for the same powder compressed to a plug of fairly low porosity. On the theory of multilayers the plug would show progressively lower adsorption than the powder as the relative pressure increased, but if capillary condensation is possible the reverse is the case. Experiments along these lines show that capillary condensation plays an important part in physical adsorption. A. J. MEE

541.183.25

3163. The properties of freshly formed surfaces. XV. The application of the contracting liquid-jet technique to the measurement of tensions at liquid-liquid interfaces. C. C. ADDISON AND T. A. ELLIOTT. *J. Chem. Soc.*, 3090–6 (*Nov.*, 1950).

See Abstr. 3471 (1950) for Part XIV.

541.183.25

3164. The properties of freshly formed surfaces. XVI. Dynamic tensions of sodium dodecyl sulphate solutions at the surface of liquid → air and liquid → liquid contracting jets. C. C. ADDISON AND T. A. ELLIOTT. *J. Chem. Soc.*, 3096–103 (*Nov.*, 1950).

541.183.25

3165. The properties of freshly formed surfaces. XVII. The measurement of surface and interfacial tensions of solutions, employing stationary waves on a vertical jet. C. C. ADDISON AND T. A. ELLIOTT. *J. Chem. Soc.*, 3103–9 (*Nov.*, 1950).

541.183.26

3166. The anisotropy of nitrogen adsorption on single crystal copper surfaces. T. N. RHODIN, JR. *J. Amer. Chem. Soc.*, **72**, 5691–9 (*Dec.*, 1950).

The isosteric heats of physical adsorption of N near its boiling-point on reduced and oxidized electropolished single crystal Cu surfaces have been studied. The adsorption isotherms were determined with a quartz beam vacuum microbalance of high sensitivity. The surfaces studied are believed to be good approximations to flat, clean, undistorted single crystals. The heats of adsorption were found to vary in a unique manner with the coverage, uniformity and crystallography of the surfaces. The physical significance of these studies has been evaluated qualitatively within the frame of established theoretical understanding of adsorption phenomena on single crystal metal surfaces. A.

541.182.3

3167. A thermal precipitator for the gravimetric estimation of solid particles in flue gases. J. BREDL AND T. W. GRIEVE. *J. Sci. Instrum.*, **28**, 21–3 (*Jan.*, 1951).

The instrument described is designed to collect all the solid matter from a representative sample of flue gases, and to handle a sufficiently large sample of gas for the deposit to be easily weighed. Its advantage over the usual filtering methods are that it does not offer excessive resistance to the gas flow, and that it is apparently capable of retaining the smallest size of particle present in flue gases. In addition, the use of Al foil collecting surfaces facilitates accurate weighing, since, unlike the usual filtering materials, their capacity for adsorbing moisture is negligible. A.

541.183.5

3168. An interesting example of adsorption and purification in the solid phase. E. BELLET AND P. LEVERT. *C.R. Acad. Sci., Paris*, **231**, 1484–5 (*Dec.* 18, 1950) *In French.*

Describes the purification of commercial naphthalene (m.p. 78·5°c) by mixing it at room temperature with ca. 10% of a decolorizing earth and allowing the mixture to react during 20–30 hr, stirring from time to time. After treatment with benzene and filtration a naphthalene having a m.p. of 79·6°c is obtained, while the earth on the filter retains the pink-coloured contamination. F. LACHMAN

CHEMICAL STRUCTURE 541.4/.6

541.57 : 530.145

3169. Errata: Quantum-mechanical resonance between identical molecules. H. JEHLE. Letter in *J. Chem. Phys.*, **18**, 1681 (*Dec.*, 1950).

See Abstr. 720 (1951).

541.57 : 539.132

The homopolar bond in the hydrogen molecule. *See Abstr.* 2896

541.57 : 539.133

3170. Factors influencing bond dissociation energies. M. SZWARC. *J. Chem. Phys.*, **18**, 1660–3 (*Dec.*, 1950).

The calculations leading to estimates of resonance energies of various molecules and radicals are analysed and the ambiguities involved are stressed.

It is suggested that an alternative approach to problems of molecular energetics may be provided by analysing the variations in bond dissociation-energies. Consideration of bond dissociation-energies leads to estimates of "experimental resonance energies" of radicals, and to an evaluation of a "strengthening effect" influencing the undissociated molecule. The new approach is one of several possible variants which might be used to arrive at a better understanding of energetic relationships in molecules. A.

541.6

3171. The structure of synthetic polypeptides. I. X-ray investigation. C. H. BAMFORD, W. E. HANBY AND F. HAPPEY. *Proc. Roy. Soc. A*, **205**, 30–47 (*Jan.* 22, 1951).

Oriented fibres and films of a number of synthetic polypeptides have been prepared, and examined by X-ray diffraction. It is shown that the polypeptides can exist in a folded (α) and an extended (β) configuration. The observations on the α form are consistent with the presence of a twofold screw axis in symmetrical polypeptides, and lead to a value of about 5·5 Å for the true fibre repeat distance. The fibre period in the copolymers is shown to be greater than 5·26 Å. It is considered that the X-ray evidence favours a ribbon-like molecule. The β forms of the polypeptides give X-ray diagrams similar to those of β proteins, and probably consist of extended polypeptide chains. It is shown that the polypeptides can undergo an $\alpha \rightleftarrows \beta$ transformation similar to that encountered in the fibrous α proteins. The medium from which the peptide is regenerated has a very important influence in determining which form is obtained. A.

541.6

3172. The structure of synthetic polypeptides. II. Investigation with polarized infra-red spectroscopy. E. J. AMBROSE AND A. ELLIOTT. *Proc. Roy. Soc. A*, **205**, 47–60 (*Jan.* **22**, 1951).

Methods of producing oriented films of synthetic polypeptides when prepared from various solvents are described. The polarized i.r. spectra of a number of these films have been measured. It is shown, in agreement with earlier work, that the polypeptides can exist in a folded (α) and an extended (β) configuration. In the α form the N—H and C=O stretching modes of the polypeptide chain show parallel dichroism while the N—H deformation mode shows perpendicular dichroism. In the β form these conditions are reversed. The α form has characteristic frequencies of about 1 660 and 1 560 cm^{-1}, while the β form has characteristic frequencies of about 1 640 and 1 530 cm^{-1}. When highly dispersed in an inert polymer or liquid solvent it is shown that all the H bonds of the polypeptide chain can be internally satisfied. It is concluded that in the folded state the chain is maintained in the form of 7-membered rings by intra-molecular H bonds. A.

541.632 : 539.133

3173. Rotational isomerism and the vibrational spectrum of 1, 2-dibromoethane. J. T. NEU AND W. D. GWINN. *J. Chem. Phys.*, **18**, 1642–52 (*Dec.*, 1950).

An assignment of the vibrational frequencies of CH_2BrCH_2Br and CD_2BrCD_2Br has been made. The Raman spectra of these compounds have been redetermined using the new "Toronto"-type Hg arcs. It was possible, in the case of CH_2BrCH_2Br, to obtain a number of combination and overtone bands which were of assistance in the assignment. The liquid-phase i.r. spectra of both compounds have been redetermined with greater resolution and spectral range than had been previously reported. The solid i.r. spectra of the same compounds were also determined in order to separate bands due to the trans isomer from those due to the skew isomer. Evidence for the C_2 symmetry of the high-energy form has been given. A.

541.64

3174. Disintegration of solutions of polymethacrylic esters. E. JENCKEL AND K. GORKE. *Z. Naturforsch.*, **5a**, 556–63 (*Oct.*, 1950) *In German.*

Critical data are assembled from solutions of polymethacrylic acid–methyl ester in 65 solvents. Thermodynamic relations of the critical co-ordinates with respect to degree of polymerization, confirm essentially the statistical formula proposed by Miller, Huggins and Flory [cf. *J. Chem. Phys.*, **9**, 440, 660 (1941); **10**, 51 (1942)]. H. H. HODGSON

541.64

3175. On the precipitation threshold of solutions of heterogeneous polymers. H. TOMPA. *Trans. Faraday Soc.*, **46**, 970–6 (*Nov.*, 1950).

The precipitation threshold of heterogeneous polymers is calculated on the basis of the Flory–Huggins theory of polymers and the results applied to some existing data. A.

541.64

3176. Intramolecular reaction in polycondensations. I. The theory of linear systems. H. JACOBSON AND W. H. STOCKMAYER. *J. Chem. Phys.*, **18**, 1600–6 (*Dec.*, 1950).

For 3 types of linear polycondensing systems, equilibrium molecular size-distributions, including rings as allowable species, are derived. Average molecular weights and amounts of ring and chain fractions are calculated therefrom. The fractions of rings are shown to increase with dilution, and with molecular weight. It is shown that beyond a critical dilution it is sometimes possible to obtain 100% yield of rings by driving the condensation to completion. Detailed calculations are made for 2 important cases corresponding to condensations of the decamethylene glycol-adipic acid type: for equimolar amounts of the 2 monomers; for unequal amounts, with 1 monomer type completely reacted. A.

541.64

3177. Intramolecular reaction in polycondensations. II. Ring-chain equilibrium in polydecamethylene adipate. H. JACOBSON, C. O. BECKMANN AND W. H. STOCKMAYER. *J. Chem. Phys.*, **18**, 1607–12 (*Dec.*, 1950).

Decamethylene adipate polymers prepared in the absence of solvent undergo a reversible decrease in solution viscosity when heated for long times in chlorobenzene. This phenomenon is shown to be due to ester interchange reactions which establish equilibrium between ring and chain molecules. Quantitative agreement with the equilibrium theory of the previous paper is obtained if the effective

length of a chain link is taken as $4 \cdot 5 \pm 0 \cdot 2$ Å, which is of the order of magnitude to be expected from hindered rotation and steric effects. Measurements of ring-chain equilibrium thus appear to offer a useful method for characterizing the stiffness of relatively short and flexible chains. A.

541.64 : 534.23

3178. The ultrasonic degradation of polymers. H. W. MELVILLE AND A. J. R. MURRAY. *Trans. Faraday Soc.*, **46**, 996–1009 (*Nov.*, 1950).

The ultrasonic degradation of dilute solutions of polymethyl methacrylate and polystyrene have been investigated under conditions in which no cavitation occurs. Degradation is much slower than when cavitation is allowed to take place. Osmotic pressure determinations of molecular weight show that true fission of polymers occur. Attempts have been made to find whether fission produces radicals or molecules by carrying out experiments in monomers in presence of iodine. The evidence shows that degradation into molecules seems to be preferred. Monomeric styrene is shown on the other hand to be induced to polymerize by ultrasonic radiation. A.

CHEMICAL ANALYSIS 543/545

545.3

3179. Polarography of mercury. P. SILVESTRONI. *Ric. Sci.*, **20**, 1861–6 (*Dec.*, 1950) *In Italian.*

Mainly a critical survey of the literature. Special reference is made to the use of polarization curves to investigate the formation of complex ions of Hg salts in solution alone and in presence of salts of the alkali metals. The references quoted are from "Bibliografia polarografica, 1922–1929," by G. Semerano, published as a supplement to the above review. J. GRANT

545.372

3180. A study of the polarographic behavior of dropping amalgam electrodes. N. H. FURMAN AND W. C. COOPER. *J. Amer. Chem. Soc.*, **72**, 5667–75 (*Dec.*, 1950).

A quantitative study of simple and composite amalgams of Zn, Cd, Tl, Pb and Cu. An apparatus and technique are described whereby amalgams of known concentration can be prepared and dropped through a capillary in the virtual absence of air. A comparison of the half-wave potentials for amalgam anodes with the corresponding cathodic half-wave potentials at the dropping Hg electrode in the same media gives valuable indications as to the reversibility of electrode processes. Diffusion coefficients for individual metals through Hg may be derived from the polarographic data on amalgam anodes. In certain cases the results strongly suggest that there may be compounds between metals dissolved in Hg, even at great dilutions. The concentration of a single metal in Hg may be estimated to good approximation by anodic polarography but the method is less satisfactory when several metals are present. A.

545.8

3181. Radioactivity of thoriated tungsten wire. I. NONAKA AND S. TANABE. *J. Phys. Soc. Japan*, **5**, 398–402 (*Nov.–Dec.*, 1950).

The relative content of Th of thoriated W wire can be assessed by measuring the β-ray activity. For a determination of the absolute value chemo-analytical methods are indispensable. A complicating factor is the evaporation of the radioactive elements during the heat treatment, and it becomes necessary to know the exact rate of evaporation before correct calculations can be carried out. The mathematical treatment of the problem is dealt with in detail. W. SUMMER

545.8 : 539.185.7

3182. Method for estimation of boron in Pyrex based on absorption of thermal neutrons. J. GOVAERTS. *Experientia*, **6**, 459–61 (*Dec.*, 1950) *In French.*

Describes the use of absorption cross-section measurements to determine the B content of various samples of Pyrex. A Ra–Be source is used, enclosed by paraffin wax, and Dy detectors are employed. J. THEWLIS

545.82

3183. Background correction in spectrochemical analysis and effects of scattered light in the densitometer. A. C. OERTEL. *Aust. J. Appl. Sci.*, **1**, 152–63 (*June*, 1950).

Plate calibration curves (density-log. relative exposure) cannot in general be prepared from readings made on a line or on line plus background in stepped spectrograms because serious errors may be caused by scattered light in the densitometer. Curves prepared from readings made on the stepped background gave satisfactory results. Such curves were used in a test of the method of background correction in which the background is deducted as an exposure. Results were analysed statistically, and the method gave excellent results. Where the background density is less than 0·1, the correction may sometimes be made by deduction as a density without loss of analytical accuracy. Only one method of correction should be used for all samples and standards in any lot of analyses because corrected line intensities obtained by the two methods can be significantly different. A.

545.827

3184. Determination of heavy water by mass spectrometer. B. W. THOMAS. *Analyt. Chem.*, **22**, 1476–8 (*Dec.* 16, 1950).

The aqueous liquid mixtures are introduced directly into the mass spectrometer vacuum system and the analysis is based on the relative abundances of mass 19 from DOH and mass 18 from HOH. Calibration data are obtained from known mixtures covering the desired range of heavy water in water. The method appears to be accurate to $\pm 0 \cdot 2\%$ in the range of $0 \cdot 2\%$ to 1% and to $\pm 0 \cdot 3\%$ in the range of 1 to 10% D_2O. Instrument and calculation time requirements are 15 to 20 min per analysis. A.

545.844

3185. Use of ultra-violet rays in chromatographic analysis in the adsorption column. E. M. BRUMBERG, I. N. BEREZHNAYA, U. P. DUTKINSKIĬ AND S. E. MANOĬLOV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 747–50 (1950) *In Russian.*

545.844 : 532.72

The admittance concept in the kinetics of chromatography. *See Abstr.* 2426

CRYSTALLOGRAPHY 548

548.0

3186. The criteria of enantiomorphy. N. V. BELOV. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 1) 33–5 (1950) *In Russian.*

Discussion of the way in which some screw axes can give rise to enantiomorphous pairs.

548.0 : 535.323

3187. The optical constants of $CaCl_2.4H_2O$ crystals. A. I. SHEPELEV, M. N. LYASHENKO AND I. G. DRUZHININ. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 3) 379–81 (1950) *In Russian.*

The optical constants of α, β and γ $CaCl_2.4H_2O$ [see *Dokl. Akad. Nauk, SSSR*, **72** (*No.* 4) 703–6 (1950)] were found to be: α form, refractive indices 1·571, 1·560 and 1·532, $2V = -63°$, crystals equidimensional; β form, uniaxial negative, indices 1·530 and 1·506, crystals platy; γ form, indices 1·491, 1·477 and 1·447, crystals acicular, $2V = -68°$.

A. L. MACKAY

548.0 : 536.413

3188. Thermal expansion of crystals. III. Ammonium chloride and ammonium bromide. S. S. SHARMA. *Proc. Indian Acad. Sci. A*, **31**, 339–47 (*May*, 1950).

See Abstr. 1476 (1951) for previous part.

548.0 : 536.413

3189. Thermal expansion of crystals. IV. Silver chloride, lithium fluoride and magnesium oxide. S. S. SHARMA. *Proc. Indian Acad. Sci. A*, **32**, 268–4 (*Oct.*, 1950).

548.0 : 539.373

3190. The deformation of copper and iron crystals by unidirectional abrasion. D. M. EVANS, D. N. LAYTON AND H. WILMAN. *Proc. Roy. Soc. A*, **205**, 17–30 (*Jan.* 22, 1951).

With the aim of testing further the conclusion [Abstr. 6134 (1950)] that a new deformation process, rotational slip, occurs prominently when crystal surfaces are abraded unidirectionally, an approximately {110} face of a Cu crystal was smoothed by electropolishing, abraded along $\langle 1\bar{1}0\rangle$ and examined by electron diffraction after various stages of etching. The immediate surface regions were heavily disorientated, but those slightly below the surface had mostly become rotated by about 35°, though a decreasing proportion was rotated by larger angles up to about 90°, about the cube edge lying in the surface and normal to the abrasion direction. When abrasion was along $\langle 001\rangle$ or $\langle \bar{1}12\rangle$, rotation occurred about $\langle 1\bar{1}0\rangle$ and $\langle 1\bar{1}1\rangle$ respectively. In Fe, also, large rotation of parts of the crystal surface occurred when crystals were abraded parallel to either {100}, {110} or {111} planes which were normal or steeply inclined to the surface. The interpretation in terms of rotational slip on {001}, {110} or {111} planes is fully supported by previous metallographic observations of such rotated lamellae formed parallel to these planes in Cu (and Al) and Fe, and by electron-diffraction evidence of the structure of beaten metal foils. It is pointed out that the deformation caused by the abrasion is analogous to the development of "deformation bands." A.

548.24

3191. Mechanical twinning in crystals of Rochelle salt. M. A. CHERNYSHEVA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 2) 247–9 (1950) *In Russian.*

The transition point of Rochelle salt from the monoclinic to the orthorhombic system is 24°c. Polysynthetic twinning of the monoclinic form by rotation about [001] can occur and the twin boundaries can be changed by mechanical pressure. At 20–22°c the effect of mechanical pressure was observed with a polarizing microscope. A plate specimen cut $\perp$ to [100] was pressed with a glass sphere 0·35 mm dia. between two glass plates. The whole system was immersed in a liquid. The actual area of contact could be seen through the sphere with an additional magnification of 1·5. Under light pressure the light and dark || bands changed reversibly to a chequered system. A. L. MACKAY

548.5

3192. The problem of obtaining single crystals of boron carbide. I. L. ZAGYANSKIĬ, G. V. SAMSONOV AND N. V. POPOVA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 723–4 (1950) *In Russian.*

Crystals of boron carbide (B_4C) 10 mm long and 0·4 mm thick were prepared by heating B and C in an electric resistance furnace. Near the electrodes were put artificial cavities into which the crystals grew, it is thought, by the action of B vapour on C-rich liquid.

A. L. MACKAY

548.5

3193. On the existence of a nucleation process in the controlled oxidation of iron at high temperatures. J. BARDOLLE AND J. BÉNARD. *C.R. Acad. Sci., Paris*, **232**, 231–2 (*Jan.* 15, 1951) *In French.*

Samples of pure electrolytic and Armco iron in a stable state of crystallization were oxidized for several hours under reduced pressure at 850°c. Each iron crystal was covered with a nearly uniform distribution of oxide seeds, whose surface density varied considerably for different crystals. The orientation of the oxide nuclei is closely related to that of the substrate. J. A. FRANKS

548.5 : 539.27

3194. An electron microscope study of crystal surfaces. J. AMES, T. L. COTTRELL AND A. M. D. SAMPSON. *Trans. Faraday Soc.*, **46**, 938–41 (*Nov.*, 1950).

A method of preparing crystal surface replicas for examination in the electron microscope is described. The majority of crystals studied show evidence of layer growth. When crystals are grown from solutions containing habit modificants, the layers become thicker and more numerous. Secondary surface phenomena include oriented ripples and ridges. Some possible modes of crystal growth are discussed in the light of the observations made. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

3195. Lattice sums for ionic crystals. F. C. FRANK. Letter in *Phil. Mag.*, **41**, 1287–9 (*Dec.*, 1950).

A simple and very rapidly convergent method of summation, based on the replacement of ionic charges by hexadecapole systems, is given. A. R. STOKES

548.7 : 535.34

3196. Theory of light absorption and non-radiative transitions in *F*-centres. K. HUANG AND A. RHYS. *Proc. Roy. Soc. A*, **204**, 406–23 (*Dec.* 22, 1950).

A quantitative theory for the shapes of the absorption bands of *F*-centres is given on the basis of the Franck–Condon principle. Underlying the treatment are two simplifying assumptions: namely, (*a*) that the lattice can be approximately treated as a dielectric continuum; (*b*) that in obtaining the vibrational wave functions for the lattice, the effect of the *F*-centre can be considered as that of a static charge distribution. Also considered in the paper are the probabilities of non-radiative transitions, which are important in connection with the photoconductivity observed following light absorption by *F*-centres. The probability for an excited *F*-centre to return to its ground state by non-radiative transitions is shown to be negligible; similar transitions to the conduction band are, however, important if the excited state is separated from the conduction band by not much more than 0·1 eV. The temperature-dependence of such transitions is complicated, but, for a wide range of temperatures, resembles $e^{-W/kT}$. Tentative estimates show that the result is consistent with the observed steep drop of the photoconductive current with temperature. A.

548.7 : 541.183

3197. Some particularities of adsorption brought about by "thermal disorders" on the surface of crystals. F. F. VOLKENSHTEIN. *Zh. Fiz. Khim.*, **23** (*No.* 8) 917–30 (1949) *In Russian.* English translation in *Guide Russ. Sci. Period. Lit., Brookhaven*, **3**, 251–63 (*Sept.*, 1950).

There are 4 basic types of microdefect: (*a*) an empty lattice point, (*b*) an atom or ion of a lattice placed in an interlattice point, (*c*) an ion in a heteropolar lattice situated in a normal position but carrying an anomalous charge, (*d*) a foreign atom placed in a lattice point. In general microdefects possess a mobility associated with a definite activation energy. Defects may either attract or repel one another, and may interact to produce a defect with different properties. Thus a real crystal lattice has a characteristic "chemistry of defects" and the reactions between defects may be exo- or endothermic, with or without energy of activation. The mean value of all the defects in a unit volume is the "disorder" (I) of that crystal. In general, I is in part biographical (still present at 0°K) and in part thermal.

Disorder on the surface and its role in adsorption: The surface also is characterized by a definite disorder. Each defect there may serve as an adsorption centre; the number of centres may thus vary with temperature; they may be mobile; and their number may depend on how many of them are already filled with adsorbed molecules. If all the centres are biographical one obtains the ordinary Langmuir formula.

Formation and disappearance of adsorptive centres: Cases considered are where defects A can react according to (i) a monomolecular ($A \rightleftharpoons C$), (ii) a bimolecular ($A + D \rightleftharpoons C$) law. An example of (i) is C = atom of foreign impurity, A = same atom in electronically excited state; of (ii) C = excess metal atom (M) in uppermost layer of crystal, associated with an anion hole, D = metal hole + anion hole produced by movement of M to surface of crystal, A = defect due to presence of M on surface. For (ii) the number of adsorption centres actually increases as adsorption increases and the increase is temperature-dependent. The equation to the isotherm can be worked out.

Differential heat of adsorption (ΔH) due to heat of disorder: ΔH may fall as the surface coverage increases —even when the surface is energetically uniform and when there is no interaction between the adsorbed molecules—if the number of adsorbing centres increases as adsorption increases.

Thermal disorder and the kinetics of adsorption: The exponential term in the expression for the rate of activated adsorption may arise not from an activation energy of the impinging gas molecules but from the exponential increase with temperature of the number of acceptor centres (defects). S. J. GREGG

548.73

3198. The ideal paracrystal and its coherent X-ray scattering. R. HOSEMANN. *Z. Phys.*, **128** (*No.* 4) 465–92 (1950) *In German.*

Continuation of previous work [Abstr. 9116 (1950)]. An ideal paracrystal is defined to have the property that the statistical distribution of its components [Bausteine] with respect to an arbitrarily chosen reference component is independent of the choice of reference component (a supposed example is cellulose, with a "component" of 4 glucose rings). The intensity of scattering is examined by Fourier-transform methods, and it is found that reciprocal space can be divided into a central region of low-angle scattering, enclosed by 5 concentric shells: a region of sharp reflections; a transition region of reflections broadened in varying degrees; a region of strongly broadened reflections; a region of fluid scattering; a region of characterless general scattering. The regions of validity of earlier diffraction theories are discussed. A. J. C. WILSON

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 3076–83

548.733

3199. A new type of high-temperature X-ray camera for chemical reactions in the solid state. T. KUBO AND H. AKABORI. *J. Phys. Coll. Chem.*, **54**, 1121–31 (*Nov.*, 1950).

The specimen is coated on a Pt wire heated by a stabilized d.c. source. The Pt diffraction pattern recorded, together with that of the specimen, allows the temp. of the wire to be found from the known expansion coeff. of Pt. Examples of the calculation are given. By using a specimen of quartz and determining its expansion coeffs. from the diffraction patterns, it is shown that the specimen temp. is

within a few degrees of that of the Pt. The heater unit is described in detail; the power input is so small (~ 13 W at 1370°C) that no cooling devices are needed. S. T. HENDERSON

548.733

3200. A single crystal X-ray camera for direct recording of the reciprocal lattice. J. M. TORROJA, E. PAJARES AND J. L. AMORÓS. *J. Sci. Instrum.*, **28**, 44–6 (*Feb.*, 1951).

A camera is described for obtaining undistorted records of the reciprocal lattice by the method of De Jong and Bouman. The crystal is rotated about a zone axis which is normal to the plane of the photographic film, the film itself being rotated synchronously about an axis which is parallel to the axis of rotation of the crystal. The diffracted rays from the different reciprocal lattice planes emerge as a series of cones which are concentric about this axis. An annular slit in a screen placed between the crystal and the film restricts recording to one cone at a time. The opening angle of the cones, which would normally widen with the distance ζ of reciprocal lattice planes from the origin, is kept constant by varying the angle μ between the incident beam and the axis of rotation; the path lengths traversed by diffracted rays from different reciprocal lattice planes are thereby kept constant. A.

548.734

3201. On the theoretical effect of the geometry of the experimental arrangement on the formation of Debye–Scherrer lines using a divergent beam. C. STORA. *C.R. Acad. Sci., Paris*, **232**, 84–6 (*Jan.* 3, 1951) *In French.*

548.734.3

3202. New method of forming powder striations. M. D. WALLER. Letter in *Nature, Lond.*, **166**, 961–2 (*Dec.* 2, 1950).

548.734.3 : 539.26

3203. On the X-ray absorption correction for encased diffracters in the Debye–Scherrer technique. H. L. RITTER, R. L. HARRIS AND R. E. WOOD. *J. Appl. Phys.*, **22**, 169–76 (*Feb.*, 1951).

In dealing with numerical values for relative intensities derived from the Debye–Scherrer technique, the alteration of diffracted intensities produced by absorption in the sample cannot be ignored. Claassen has shown how this effect can be allowed for in the case of homogeneous cylindrical samples. This paper deals with a sample consisting of a cylinder surrounded by another annular cylinder both when the core is inert (i.e. absorbing and producing only extraneous scattering) and when the annulus is inert. The method is applied to show how the diffraction pattern for a liquid enclosed in a glass container may be corrected for the diffuse diffraction of the container as well as for absorption in the liquid and in the glass. A.

548.734.5

3204. X-ray goniometry from polychromatic exposures of a stationary crystal. S. S. KVITKA AND M. M. UMANSKIĬ. *J. Tech. Phys., USSR*, **20**, 901–9 (*Aug.*, 1950) *In Russian.*

Method permits of finding from 3 Laue-grams all important directions of the direct and inverse lattice, determining the crystal system and the orientation of its main axes, independent of the external shape of the crystal and its syngony. From the size of the "blind" regions on the Laue-gram the values of the periods of identity can be found. From a Laue-gram taken with mixed radiation of an orientated crystal the identity period may be calculated along one of the crystal axes. B. F. KRAUS

548.735

3205. Precision lattice-parameter measurements. H. D. KEITH. Letter in *Proc. Phys. Soc., Lond., B*, **63**, 1034–6 (*Dec.*, 1950).

Lattice parameters of quartz were measured using a 6·4 cm Straumanis camera [Abstr. 7418 (1949)] and a 19 cm "Unicam" camera. Agreement to within ~ 1 part in 10^5 was obtained. Possible errors due to finite crystal size are discussed. A. R. STOKES

548.735.46

3206. Limitation of electron density by the Patterson function. M. J. BUERGER. *Proc. Nat. Acad. Sci., Wash.*, **36**, 738–42 (*Dec.*, 1950).

The electron density $\rho(x, y, z)$ is connected with the functions $\Pi_n(x, y, z)$ [Abstr. 9125 (1950)] by the inequality $\rho \leqslant K\sqrt[n]{\Pi_n}$, where K is a constant depending on the vector polygon used in constructing Π_n. The restriction on ρ imposed by this equation is not great in practice, however, and a more restrictive function, satisfying the same inequality, is $M_n(x, y, z)$, where M_n is the least of the n values of the Patterson density at the n points of the known vector polygon displaced x, y, z from the origin of the Patterson synthesis. In the particular case M_2 (e.g. the vector polygon being merely the line joining two heavy atoms related by a centre of symmetry) the inequality becomes $\rho \leqslant \frac{1}{2\rho_a} M_2$ [where ρ_a appears to be the electron density at the centre of the known heavy atom a]. This may exclude large regions of the cell as possible atomic positions, on the ground that the electron density at the atomic centre is greater than allowed by the inequality.

A. J. C. WILSON

548.735.46

3207. Relations between the structure and the symmetrized Patterson function. F. BERTAUT. *C.R. Acad. Sci., Paris*, **231**, 1320–2 (*Dec.* 6, 1950) *In French.*

More general methods related to Buerger's implication function [Abstr. 2208 (1949)] and the superposition functions of Clastre and Gay [Abstr. 7613 (1950)] are developed by means of "folding" theory.

A. J. C. WILSON

548.736.1

3208. X-ray and neutron diffraction by graphite layers. G. E. BACON. Letter in *Nature, Lond.*, **166**, 794 (*Nov.* 4, 1950).

Anomalous X-ray diffraction intensities from certain planes in graphite may be explained on the assumption that the L-electrons are concentrated about the centres of the C–C bonds and not distributed spherically about the nucleus. This explanation is supported by neutron diffraction measurements which show no anomalous intensities, being concerned with

the nuclei only and not with the electrons. X-ray measurements at 20° and 500°c show that the anomalous X-ray intensities are not explained by a temperature factor. J. THEWLIS

548.736.1

3209. Accurate determination of the lattice of beta-titanium at 900° c. D. S. EPPELSHEIMER AND R. R. PENMAN. Letter in *Nature, Lond.*, **166**, 960 (*Dec.* 2, 1950).

548.736.3

3210. Atomic diffraction of X-rays in copper-zinc alloys. A. V. BEZNOSIKOVA AND V. I. IVERONOVA. *J. Tech. Phys., USSR*, **20**, 666–9 (*June*, 1950) *In Russian.*

When a solid solution is formed, the displacements of the atoms of different kinds are in a statistical disorder distribution in the lattice modes. Taking as atomic factor f_0 the mean value of the factors of the mutually replacing elements, if $C\%$ of the atoms A are replaced by B atoms, the atom factor is calculated thus: $100f_0 = f_{0A}\ (100 - C) + Cf_{0B}$, where f_{0A} and f_{0B} are the individual atom factors. Deviations from this rule are due to variation of bond forces of atoms on formation of solid solution, i.e. mean values of thermal vibration amplitudes cannot remain the same as in pure metal; hence the alteration of the characteristic temperature of the alloy and of the temp. coefficient. It might be expected to fall with increasing concentration of solid solution. As it is proportional to propagation velocity of elastic waves in the crystal, it must fall with reduction of Young's modulus, which occurs in solid solution (against pure metal). The reduction of characteristic temp. entails weakening of intensity of X-ray interferences at larger angles θ. Another reason for variation in X-ray interferences are lattice distortions on formation of solid solution. These facts are actually observed, the suitability of the method to Cu–Zn alloys being based on the fact of the nearly equal absorption coefficient of the two metals for Cu radiation. B. F. KRAUS

548.736.3

3211. Crystal structures of lead titanate and of lead-barium titanate. G. SHIRANE, S. HOSHINO AND K. SUZUKI. Note in *J. Phys. Soc. Japan*, **5**, 453–5 (*Nov.–Dec.*, 1950).

$BaTiO_3$ and $PbTiO_3$ form a continuous series of tetragonal solid solutions, a and the cell volume decreasing and c increasing with Pb content; $PbTiO_3$ has $a = 3{\cdot}891$, $c = 4{\cdot}141$ Å, $c/a = 1{\cdot}064$. The ferroelectric Curie temperature increases from slightly over 100°c for the Ba compound to about 500°c for the Pb. A. J. C. WILSON

548.736.4

3212. X-ray crystallography of cyanamide, H_2NCN. C. L. CHRIST. Note in *Acta Cryst.*, **4**, 77 (*Jan.*, 1951).

Unit cell dimensions: $a = 9{\cdot}03 \pm 0{\cdot}02$, $b = 7{\cdot}06 \pm 0{\cdot}02$, $c = 6{\cdot}82 \pm 0{\cdot}01$ Å. Space group *Pbca*, in which the general positions are eight-fold.

548.737

3213. Preliminary examination of the crystal structures of colchiceine and its copper salt. J. D. MORRISON. Note in *Acta Cryst.*, **4**, 69–70 (*Jan.*, 1951).

GEOPHYSICS 55

550.3

3214. The economic and scientific importance of geophysical methods for the investigation of the structure of mountain ranges and of usable deposits. L. MINTROP. *Schweiz. Arch. angew. Wiss. Tech.*, **16**, 321–35 (*Nov.*, 1950) *In German.*

Text of a lecture given in March, 1950, at the 159th Meeting of the Swiss "Verband f.d. Materialprüfungen d. Technik," held at the Technische Hochschule in Zurich. It gives a comprehensive and critical account (illustrated by 37 partly new diagrams) of the present-day achievements in the various geophysical lines of attack, i.e. the seismic, gravimetric, magnetic, electrical, radioactive and geothermal methods. A. BEER

550.3 : 517.946

3215. Mathematical problems in geophysics. E. HARDTWIG. *Ann. Geofis.*, **3**, 315–35 (*July*, 1950) *In German.*

It is emphasized how every progress in the treatment of non-linear partial differential equations of the 2nd order is closely bound up with a corresponding progress in the solution of fundamental geophysical problems. The author illustrates this, in particular, in connection with his own contributions to hydrodynamics. A. BEER

550.341

3216. The absolute calibration of a brush accelerometer and its response to square waves of displacement and velocity. P. M. HONNELL. *Trans. Amer. Geophys. Un.*, **31**, 690–5 (*Oct.*, 1950).

A new method for the absolute calibration of seismographs and accelerometers dynamically is based upon matching the peak sinusoidal acceleration of the instrument on test against the constant vertical acceleration of gravity. The technique appears to have a precision of 5 parts per 100. A.

550.341 : 541.127

The physical chemistry of detonative reactions. *See Abstr.* 3127

550.342

3217. On the physical nature of microseisms. G. D'HENRY. *Ann. Geofis.*, **3**, 87–94 (*Jan.*, 1950) *In Italian.*

Examination of a series of microseisms of known origin leads to the conclusion that it is impossible to determine their direction of approach from the records of a single station. This is due to the distortion of the waves during travel by reflection and refraction at discontinuities in the earth's crust. E. M. FOURNIER D'ALBE

550.342

3218. On the nature of the causes of microseisms. M. GIORGI AND E. ROSINI. *Ann. Geofis.*, **3**, 173–213 (*April*, 1950) *In Italian.*

In order to determine what meteorological factors are concerned in the formation of microseisms, the synoptic charts of the Mediterranean region were examined simultaneously with the records of microseisms at Rome throughout the year 1949. Attention was concentrated on the microseisms of period less than 4 sec, known to be of local origin. No connection was found between the period or intensity of the microseisms and either the passage of depressions or fronts, or the wind strength or direction. In nearly all cases, however, microseismic activity coincided with the presence over the open Mediterranean of centres of positive barometric tendency, either stationary or in motion, which appear to be the cause. E. M. FOURNIER D'ALBE

550.361

3219. Heat flow in the earth. S. K. RUNCORN. *Nature, Lond.*, **166**, 974–6 (*Dec.* 9, 1950).

Report of a British Association meeting held on Sept. 4, 1950, on problems concerning heat flow in the earth. Professor Jeffreys considered the possibility that heat output of the radioactive decay of the rare isotope K^{40} in the earth's crust, though now smaller than that of U and Th, might have been much greater in the earth's early history. Dr. S. K. Runcorn considered the geomagnetic secular change and the thermal convection in the earth's core specially in relation to Bullard's and Elsasser's suggestion that thermal convection must be postulated as possible causes of motions in the core of the earth (rather than astronomical ones) which may be responsible for the secular change. Dr. G. M. Lees considered that shrinkage of the earth's core and slow cooling provided an adequate mechanism for formation of fold and mountain ranges. Professor Jeffreys's view was also that contraction of the earth gave an answer of the right order of magnitude to the problem of the cause of mountain building. Dr. Inglis drew attention to Professor Urey's view that the lighter constituents of the earth's crust might have condensed first.

V. C. A. FERRARO

550.381

3220. New criteria for the reduction of magnetic observations. C. MORELLI. *Ann. Geofis.*, **3**, 349–55 (*July*, 1950) *In Italian.*

The author discusses the organization of magnetic surveys and stresses the advantages of replacing absolute by relative measurements in the majority of stations. For instance, a 100 km grid of 1st-order stations measuring D, H and Z may be used as a base for detailed exploration by variometers. The accuracy and probable cost of such a survey are also examined. E. M. FOURNIER D'ALBE

550.384

3221. Results on geomagnetic *K*-indices for the International Polar Year 1932–33. J. BARTELS. *J. Geophys. Res.*, **55**, 427–35 (*Dec.*, 1950).

550.384

3222. "Sudden commencements" in geomagnetic field variations. S. K. CHAKRABARTY. Letter in *Nature, Lond.*, **167**, 31 (*Jan.* 6, 1951).

550.385 : 551.594.51

3223. The theory of magnetic storms and auroras. D. F. MARTYN. *Nature, Lond.*, **167**, 92–4 (*Jan.* 20, 1951).

Chapman and Ferraro's theory is confirmed and extended by new studies of the interactions between magnetic fields and motions of fluid conductors. The westward ring current, which produces the decrease in H, necessarily arises from the curved flow of the solar stream past the earth, this current interacting with the geomagnetic field to balance the centrifugal forces. The ring is radially polarized, and its estimated size is such that the geomagnetic lines of force which intersect it pass through the auroral zones. Charges are expelled from its surface along the lines of force and impinge on the zones with sufficient energy to cause auroras. A polarization field of order 10^5 V is produced across each zone and, interacting with the magnetic field, causes ions to drift along the zone. If positive ions drift faster than negative ones, a Hall current flows round each zone on the first day of a storm, westwards in the a.m. hemisphere and eastwards in the p.m., thus giving the observed high-latitude field. This Hall current also sets up a polarization field which impels the world-wide ionospheric currents responsible for S_D. The vertical electron-drifts associated with these currents lead to the observed changes in the height and density of the F_2-layer. A. T. PRICE

550.387

3224. On the phase-law in earth currents. J. ORIOL CARDÚS. *Rev. Geofis.*, **9**, 215–33 (*July–Sept.*, 1950) *In Spanish.*

The variation of phase with the lunar day (phase-law) and the different amplitude of the semi-diurnal wave obtained when the lunar diurnal variation of the earth's magnetism is computed for a particular day of the lunar month are produced by the sun. The same type of curves is obtained, as was to be expected, for the lunar effect on earth currents at the Ebro Observatory. The same curves for the diurnal variation of earth currents at different lunar phases are obtained from the Ebro data by the ordinary method of computation and by synthesis from the lunar and solar diurnal variation for all days taking into account the different duration of the lunar and solar days. M. DOPORTO

550.389

3225. The magnetic field of the earth and the world oceans. V. V. SHULEĬKIN. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 1) 57–60 (1951) *In Russian.*

550.93

3226. A method of determining the age of the earth. C. FESTA AND M. SANTANGELO. *Ann. Geofis.*, **3**, 251–61 (*April*, 1950) *In Italian.*

The age of the earth is estimated from the relative abundance of K^{40} and Ca^{40} in the earth's crust and in meteorites. Assuming for the decay of the potassium a value of $\lambda = 1{\cdot}97 \times 10^{-9}\ \mathrm{yr}^{-1}$, the method gives an age of $3{\cdot}16 \times 10^9$ yr, with an estimated accuracy of 19%. E. M. FOURNIER D'ALBE

550.93 : 539.16.08

3227. Determination of the age of igneous rocks. S. Miholić. *J. Chem. Soc.*, 3402–5 (*Dec.*, 1950).

In view of the importance of determinations of age in geochemical prospecting for ore deposits, an attempt has been made to determine geological age directly in rock samples. Owing to the extremely small amounts of the relevant elements occurring in rocks, mass-spectrographic analysis of the inactive end-products is not practicable and the determinations of age have been made by two independent methods, viz. the "lead" and the "strontium" method. As spectrographic methods are not sensitive enough for lead, it was determined by a polarographic method. Except for samples of a granite and a granulite from the Carboniferous, the two methods gave fairly concordant results. A.

551.24

3228. On the earth tide of the compressible earth of variable density and elasticity. H. Takeuchi. *Trans. Amer. Geophys. Un.*, **31**, 651–89 (*Oct.*, 1950).

The differential equations of stress and motion are established to allow solution under various hypotheses as to elasticity, compressibility, and density in the interior of the earth, and numerical integrations are made for several earth models with internal constitutions inferred from recent studies of seismology combined with K. E. Bullen's studies of the density distribution within the earth. The results are shown to be in satisfactory agreement with several observations of earth tides. A.

551.46.018.9

3229. The thermopile wave meter. J. D. Isaacs and R. L. Wiegel. *Trans. Amer. Geophys. Un.*, **31**, 711–16 (*Oct.*, 1950).

A synthetic rubber bellows is mounted on a plastic base which is in turn mounted on a brass cable connection. A thermopile is mounted inside the bellows with one group of junctions in contact with the air chamber of the bellows, and the reference junctions, insulated from the air chamber, in thermal contact with the surrounding sea water. Thus when a wave passes over the unit, the crest and trough produce a compression and expansion of the bellows with the corresponding temperature change in the gas due to the polytropic cycle. A.

ATMOSPHERE . METEOROLOGY 551.5

551.508.5 : 621.317.39

3230. A simple form of sensitive electric contact cup anemometer. S. G. Crawford. *J. Sci. Instrum.*, **28**, 36–7 (*Feb.*, 1951).

By replacing the counter mechanism of a cup anemometer with a simple form of make-and-break electric contact, an accurate indication of wind speed in the range 0·3 to 20 m/sec can be obtained with only a 6 V battery and low resistance message register in circuit. The instrument is readily portable and easy to mount, and has maintained its almost linear calibration during several investigations of wind profile over land and sea. A.

551.508.71

3231. Recirculating apparatus for testing hygrometers. A. Wexler. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 357–62 (*Nov.*, 1950).

An apparatus designed principally for research on and calibration of radiosonde hygrometer elements at temperatures above freezing, but equally useful at temperatures down to −40°c. It operates by saturating air at one temperature and then raising the air temperature sufficiently to give any desired relative humidity. The air is recirculated continuously in a closed system. Four identical, but independent, recirculating systems are employed. Discrete changes in humidity and temperature are obtained by means of a novel pneumatic valve that permits the hygrometers under test to be switched, easily, from system to system. Checks on the performance of the apparatus by means of the gravimetric method of moisture determination and the psychrometric method show an average difference in relative humidity of $\pm 1 \cdot 2\%$. A.

551.510.41 : 539.155.2

3232. The helium-3 problem of the atmosphere. P. Harteck and V. Faltings. Letter in *Nature, Lond.*, **166**, 1109 (*Dec.* 30, 1950).

Using the authors' recently found value of 1 atom of tritium (T) per cm^3 of air [Abstr. 761 (1951)] and the value of 10^{-18} for the molar conc. of T in rain-water of Libby and Grosse, the atmospheric concentration of He^3 has been calculated (*a*) including only the dry atmosphere (2×10^7 atoms of He^3/cm^3 air); (*b*) including T combined as water (5×10^9 atoms/cm^3). The experimental value is $1 \cdot 5 \times 10^8$ atoms/cm^3.

A. O. Stanesby

551.510.5 : 525.73

3233. Gaseous tail of the earth. V. G. Fesenkov. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 3) 257–62 (1950) *In Russian.*

The author's observations have led him to the conjecture that the outermost layer of the earth's atmospheric envelope is a conoid, resembling the tails of comets of Type I. A hypothetical method is indicated whereby the atmospheric components of the sky at any given point and time can be found. Results, first obtained for the atmosphere covering the side of the earth nearest the sun, next for the side in darkness, are said to show the existence of a continuous curved gaseous jet, directed outwards into space from the earth's atmosphere on the side furthest from the sun. It is argued mathematically that this conception can be reconciled with the observed features of the night sky and its parallactic shift. The reason for the formation of this "tail" is stated by the author to remain for the time being obscure.

J. Cleugh

551.510.535 : 523.74

3234. Comparison of variously derived solar indexes. H. S. Moore and M. Stein. *J. Geophys. Res.*, **55**, 423–5 (*Dec.*, 1950).

Relative merits of ionospheric solar indexes, obtained from (*a*) 27-day and monthly median values of f^0F2, and (*b*) f^0F2 from one representative ionospheric station and from an average of three such stations, were tested by the following criteria: (i) magnitude of their standard deviations from their

running mean, and (ii) degree of correlation with f^0F2 from other stations. No significant difference was found between the merits of solar indexes derived from 27-day or monthly medians of f^0F2. Those derived from a three-station average were slightly better than those obtained from f^0F2 for a single station (Washington, D.C.). A.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 2869–73

551.521.3

3235. Scattering of light on vapour and ice particles. K. BULLRICH. *Z. Met.*, **3** (*No.* 11–12) 335–8 (*Nov.–Dec.*, 1949) *In German.*

Discusses Linke's attempt to determine the extinction coefficient of the air from measurements of light intensity at zenith. Difficulty is the uncertainty of the scattering function, which is very variable with composition of aerosols in atmosphere. The theoretical scatter functions for water, dust and ice and for various angles are set out and compared with various experimental determinations. Those by S. Gunther on the Wendelstein (1800 m) confirm the abnormal forward scattering due to ice particles.

METEOROLOGICAL ABSTRACTS

551.557 : 523.5

Drift of meteoric tracks. *See Abstr.* 2325

551.593.55

3236. Construction of a theory of crepuscular phenomena from study of the secondary dispersion. F. F. YUDALEVICH. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 6) 799–802 (1950) *In Russian.*

The following three basic assumptions of the theory are formulated: that the distribution of atmospheric density in relation to the height of the phenomenon above the earth is expressed by the equation $d = d(h)$; that the refraction of light in the earth's atmosphere is ignored; that the surface of the earth is spherical. The mathematical character of the differential of the path of a light-ray in the atmosphere is indicated and illustrated by a diagram of spherical co-ordinates. It is established that symmetrical correspondence relative to a given point in the diagram exists between the volumes found in the various zones, and that a certain uniformity of illumination also exists. The ratios of the illumination of the primary dispersion to that of the second are given, for various zenith distances (between 94° and 107°) from the sun. It is claimed that the atmosphere can thus be examined up to very high levels (200–250 km). J. CLEUGH

551.593.55

3237. Observations of twilight discontinuities. G. DE VAUCOULEURS. *C.R. Acad. Sci., Paris*, **232**, 342–4 (*Jan.* 22, 1951) *In French.*

Visual photometric observations of the zenith-sky brightness in green, or total light, made during morning and evening twilights in Sept., 1946, confirm the existence of discontinuities in the slope of the log brightness curve at solar depressions, c 6°, 9°, 10° and 12°. The latter were first reported by Grandmontagne who, with Gauzit, explained the phenomena in terms of a changing atmospheric density-gradient, a suggestion shown later to be untenable [Link, *Bull. Astr. Inst. Czechoslovakia*, **1**, 137 (1949)]. It is here suggested that the observed effects result from the contribution of separate diffusing and luminescent layers in the high atmosphere to the zenithal brightness observed at ground level. D. R. BARBER

551.593.6

3238. The light reflected by an object in fog. FRZ. BLAHA AND FRD. BLAHA. *J. Phys. Radium*, **11**, 608–10 (*Nov.*, 1950) *In French.*

A luminous source illuminates a distant object through a fog. The reflected light is received on a photocell placed close to the source. The light falling on the photocell is calculated as the object approaches the source. A graph shows the variation as a function of fog-extinction coefficient, object-reflection coefficient and size. R. W. FISH

551.594.51

3239. A new band system of N_2^+ in the infrared auroral spectrum. A. B. MEINEL. *Astrophys. J.*, **112**, 562–3 (*Nov.*, 1950).

551.594.6 : 621.396.822

3240. Atmospheric noise levels at radio frequencies near Darwin, Australia. D. E. YABSLEY. *Aust. J. Sci. Res. A*, **3**, 409–16 (*Sept.*, 1950).

Between August 25, 1944, and October 31, 1945, a practically continuous record of the average level of atmospheric radio noise at a frequency of 1·93 Mc/s was obtained near Darwin. A few measurements were also made at 5·9 Mc/s. The noise-measuring programme is described and the results obtained are presented graphically. A.

551.594.6 : 538.566.2 : 621.396.11 : 621.396.812.3

3241. Periodic fading of short-wave radio signals. S. R. KHASTGIR AND P. M. DAS. *Proc. Phys. Soc., Lond., B*, **63**, 924–30 (*Nov.*, 1950).

The main features in the experimental conditions were: (i) the operating frequency was $\ll$ the maximum usable frequency (m.u.f.) for the F-layer transmission, (ii) the frequency was slightly $>$ the m.u.f. for the ordinary wave transmission through the E-layer, and (iii) it was slightly $<$ the m.u.f. for the extraordinary wave transmission through the E-layer between the transmitting and receiving stations. The following patterns of periodic or rhythmic fading were observed: sinuous fading of comparatively quick period, considered to be of magnetoionic origin, due to the interference between the upper and lower trajectory extraordinary waves in the E-layer, the ordinary waves having passed through the E-layer; periodic or rhythmic fading of comparatively slow period, considered to be due to the beat-effect between the singly and doubly reflected waves from the $F2$ region or between the singly reflected waves from the E and $F2$ regions, the two interfering waves in different directions having suffered different amounts of Doppler change of frequency due to the vertical movement of the ionospheric layer or layers; slow periodic fading with superposed ripples, observed when the ionospheric conditions were favourable for the simultaneous occurrence of the magneto-ionic type of sinuous fading and the Doppler beat type of slow periodic fading. In a few patterns of periodic fading there was evidence of extremely high frequencies (4–12 c/s) the origin of which is unknown. A.

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.843.613

3242. Peripheral contrast thresholds of the human eye. M. A. BOUMAN. *J. Opt. Soc. Amer.*, **40**, 825–32 (*Dec.*, 1950).

Experimental results concerning the behaviour of the contrast threshold are given as obtained from about 100 000 responses of the same subject. The circular test spot of size d between 6·6′ and 8° was projected 7° nasal from the fovea. Green light was used for background and test spot. The stimulus exposure t was varied between 0·02 and 1 sec. So long as d and t are small, the behaviour of $\Delta B/B$ agrees with the explanation of de Vries: $\Delta B \sim B^{\frac{1}{2}}$. The dependence of the sensitivity of the eye on B is calculated from the precise shape of the curve for ΔB as a function of B for these combinations of d and t. The result does not contradict direct measurements of the sensitivity. For combinations of d and t values in which d or t are large, deviations from quanta explanations similar to those published in previous papers on the absolute threshold [Abstr. 1133 (1948)] are found. It appeared that these deviations are due to the fact that ΔB can never decrease below a limiting value depending on B. In a region of the B values studied, this limit for ΔB is proportional to B, so that $\Delta B/B$ is constant for large d and t values in this region. The duplicity of the retina becomes apparent in the curves representing the sensitivity of the eye as a function of B and in the behaviour of the limiting value of ΔB mentioned. A.

612.845.5

3243. Tritanopia with abnormally heavy ocular pigmentation. D. B. JUDD, L. PLAZA AND D. FARNSWORTH. *J. Opt. Soc. Amer.*, **40**, 833–41 (*Dec.*, 1950).

The chromaticity confusions characteristic of tritanopia may be represented on the (x, y)-chromaticity diagram by a family of straight lines intersecting at a copunctal point near the shortwave extreme of the spectrum locus. A case of congenital tritanopia is reported that departs from typical tritanopia, first by having a luminosity function abnormally curtailed on the shortwave end, second by having chromaticity confusions among object colours describable by straight lines on the (x, y)-plot intersecting in an area surrounding the spectrum locus at 460 mμ instead of near the shortwave extreme, and third by confusing incandescent lamp light at a colour temperature of 2 900°K with the spectrum at 586 mμ instead of the typical tritanopic value of 579 mμ. It has been found that all three of these disagreements with typical tritanopia are to be expected from a tritanope possessing normal macular pigmentation combined with an ocular pigment 5 times normal. A.

612.846

3244. Binocular eye movements at high convergence. M. P. LORD. Letter in *Proc. Phys. Soc., Lond., B*, **64**, 171–2 (*Feb.*, 1951).

615.84 : 621.396.615.17

3245. A pulse generator specially adapted for research in electrophysiology. F. LEPRI, G. MORUZZI AND E. PANCINI. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **9**, 84–90 (*July–Aug.*, 1950) *In Italian.*

Generator consists of a multivibrator with an electronic switch, monitored by a c.r.o., which can produce either sinusoidal, exponential or a sequence of rectangular waveforms. The period may be varied from 2 sec down to 1 msec and the growth from 1 μsec to whole duration of impulse, the duration from 30 μsec to $\sim$ 1 sec and the amplitude is variable from 2 mV to 200 V output $\sim$ 1 W. Application to measurement of rheobase and chronaxie is described. T. A. CHALMERS (R)

615.849

3246. Biological evaluation of 20 million volt roentgen rays. V. Bar effect in *Drosophila*. W. M. LUCE, H. QUASTLER AND E. F. LANZL. *Amer. J. Roentgenol. Radium Ther.*, **64**, 963–7 (*Dec.*, 1950).

See Abstr. 7673 (1950) for Part IV. The eye of *Drosophila melanogaster* serves as a biological dosimeter. In this experiment the larva has been irradiated and the effect noted in the animal after it hatched from the pupa. The average dosis rates in the two tests were 410 r/min and 59 r/min. A weighted mean of 0·014 facet reductions/r has been obtained as a first approximation (roentgen irradiation). The betatron figure is 0·0119. The values obtained were evaluated by statistical methods. The value for the efficiency $\eta(2 \times 10^7$ V at 200 kV) was found to be 0·85. W. SUMMER

615.849 : 537.531

Dosage units for high-energy radiation. *See Abstr.* 2725

PHOTOGRAPHY 77

771.35

3247. A wide-angle, underwater camera lens. E. M. THORNDIKE. *J. Opt. Soc. Amer.*, **40**, 823–4 (*Dec.*, 1950).

An underwater camera lens covering a half-field of 37·5° is described. The area imaged with this lens is more than 7 times that covered with the customary arrangement of a conventional camera lens behind a plane window. A.

771.535

3248. Photochemical dissolution of the latent image centres and spectral photosensitivity of a photographic emulsion. S. G. GREMISHIN AND P. V. MEIKLYAR. *J. Tech. Phys., USSR*, **20**, 975–9 (*Aug.*, 1950) *In Russian.*

If a non-sensitized photo-emulsion is first exposed to blue and subsequently to red or i.r. light, the development reveals a less intense blackening than

without such an additional exposure (Herschel effect). It is explained by the photochemical decomposition, by the subsequent red irradiation, of the latent image centres formed by the blue light. The dissolution degree depends on the blackening density produced by the blue light. A definite "equilibrium" value of the density corresponds to each wavelength of the red light. At lower blackening densities red light of a given wavelength produces an additional number of latent image centres and as a result the blackening density rises, whilst at a greater density (originally) the red light reduces the number of centres, thus blackening density falls. If the blue light produces exactly this "equilibrium" density of blackening, the red light will not alter anything. The value of the "equilibrium" density depends on spectral composition of acting red light and is reduced with increasing wavelength. Apparently in this case the blue light produces initially such a number of centres that the probability that the absorption of red light of the given wavelength by the latent image centres will lead to their dissolution equals the probability of the absorption of the same red light by the basic components of the emulsion. This leads to the formation of new latent image centres. An explanation is offered, based on local interruptions of the lattice and the action of the electrons liberated thereby. The relationships found are borne out by experiments with some photographic materials.

B. F. KRAUS

778.3

3249. Photography of high altitude aerial objects. C. N. NELSON AND D. H. HAMSHER. *J. Opt. Soc. Amer.*, **40**, 863–77 (*Dec.*, 1950).

An experimental study of the photography, from the ground, of objects in the upper atmosphere shows that the results are improved by the use of long-focal-length lenses, high contrast film, and colour filters chosen with regard to the relative spectral qualities of the object and the sky background. The most difficult problem was the photography of dark grey objects against a blue sky, and for these conditions a blue filter gave best results. For these same conditions, an increase in vertical range (altitude) was found to give a greater decrease in subject contrast than an equal increase in horizontal range. Of lesser difficulty was the photography of bright, white objects against a blue sky; and for these conditions a red filter gave best results. Data were obtained regarding the optimum spectral-reflectance characteristics of targets for special purposes. The required characteristics of the photographic emulsion were the subject of a detailed study. A high-contrast, high-speed panchromatic film, especially designed for this work, is described. Exposure and processing data for this film are given.

A.

778.37 : 541.127

Two new streak cameras. *See Abstr.* 3128

778.37 : 541.127

A new photographic method for studying fast transient phenomena. *See Abstr.* 3129